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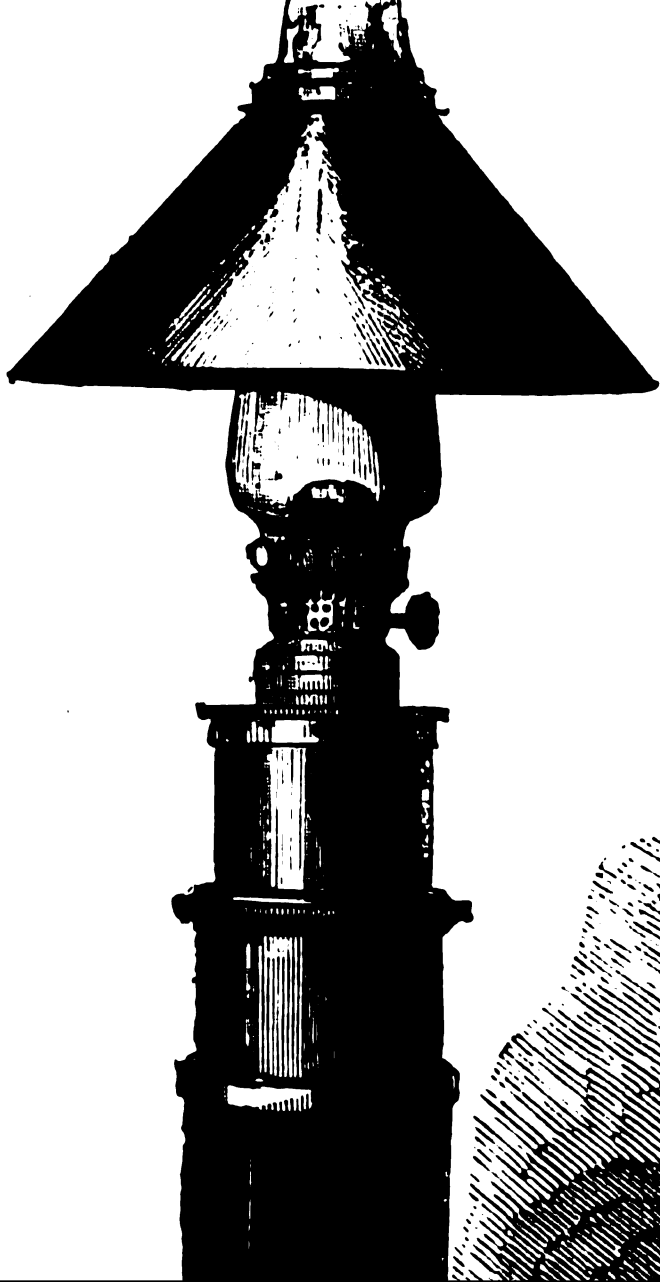
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The Popular Science Review

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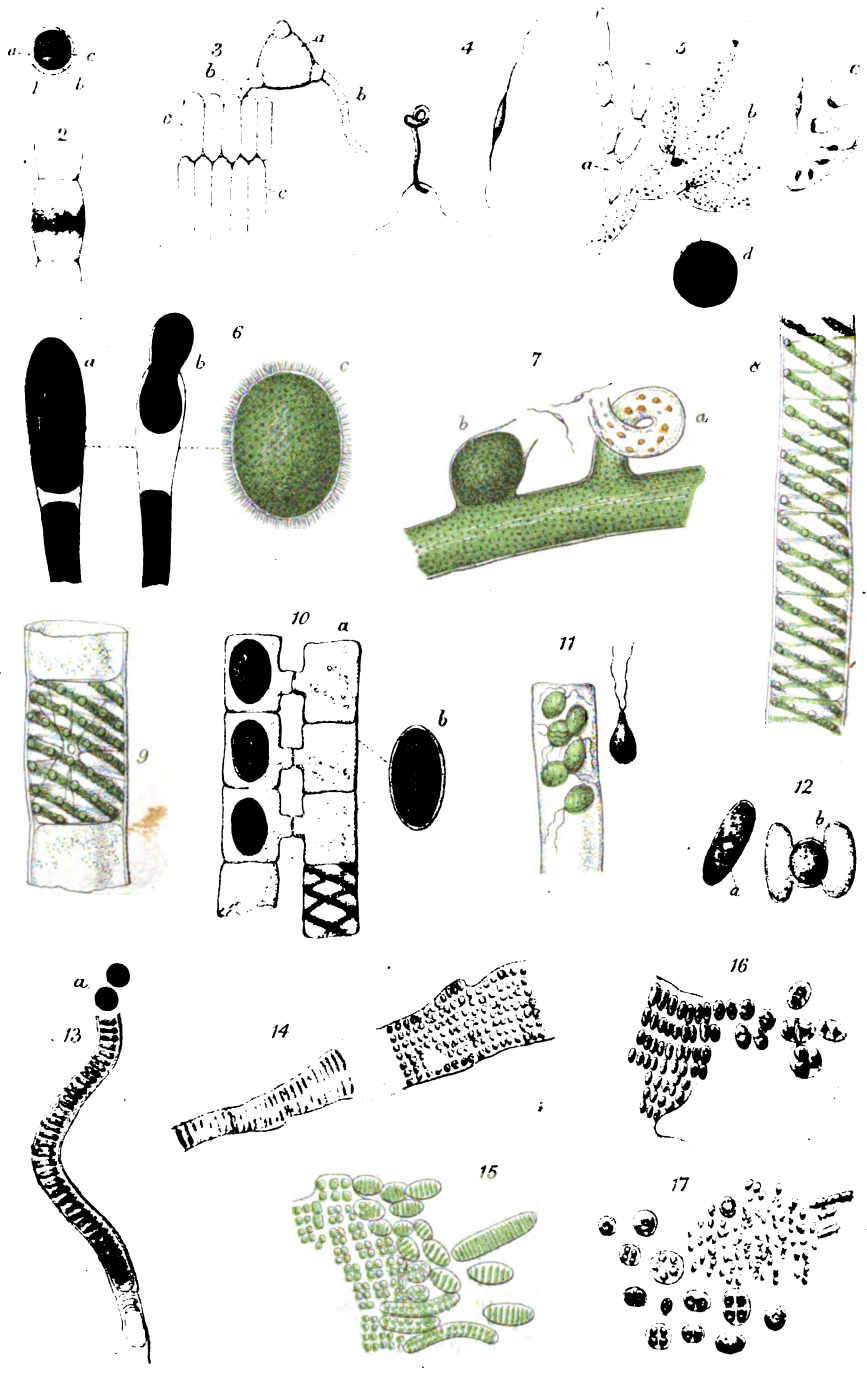
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Common fresh water Algae

THE
POPULAR SCIENCE
REVIEW.

A QUARTERLY MISCELLANY OF
ENTERTAINING AND INSTRUCTIVE ARTICLES ON
SCIENTIFIC SUBJECTS.

EDITED BY HENRY LAWSON, M.D.

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POPULAR SCIENCE REVIEW.

ON THE

MODE OF GROWTH OF SOME OF THE ALGÆ.

ILLUSTRATED BY A FEW OF THE COMMON KINDS.

BY J. BRAXTON HICKS, M.D., F.R.S., F.L.S., &c.

THE botanist who confines his attention to the study of the flowering (or, as they are called, phanerogamous) plants has a task relatively easier than he who devotes his attention to the so-called *simpler* forms of vegetable life. For, even if we exclude the fact that the principal portion of the phenomena of the former is visible to the naked eye, the changes which they undergo are considerably less and more regular than those of the lower order, and by far more easily observed. The term "simple" can only apply to the more simple composition of their component parts, while the number of changes which their forms undergo more than counterbalance this point in the time and trouble required for observation. Besides this, the tedium of watching the changes they pass through, and the difficulty of preserving them in their natural condition in order to secure the same changes, make their study one of much more arduousness than is to be found in observing the higher classes. Take, for instance, the growth from the seed: how easy it is to observe its construction and its germination, the formation of the various parts, the radicles, the ascending stem, the leaves with their various appendages, the flower and its parts, lastly, to the ovule. There is one rather difficult subject, however, which is not to be seen without care—namely, the fertilisation of the ovula, or young seed. Yet the difficulties attending the study of the lower (flowerless, or cryptogamia) forms are of a different class. Here the study requires protracted watching;

and as most of them are of aquatic habits, exceedingly susceptible of any change, whether in the amount of light or in the quality of the water, the trouble of keeping them under constant observation has done much to retard our knowledge of them, and to render the number of our observers small. Add to this that their outward forms change considerably, if not in some instances completely, and that the changes once induced may continue as long as the same external conditions which produced the changes remain.

To this point I have already called attention in a former paper, and its importance in this study is of great moment. Formerly the old observers were content to consider each form as the permanent condition; and in works of not many years since it may be read how this species of *Protococcus* or that of *Oscillatoria*, &c. were sent *dried* by post. This was unavoidable in the infancy of the study, but now it is indefensible; and nothing must be considered but as provisionally placed whose whole mode of growth has not been well observed.

After these remarks, let us now pass on to the consideration of those phenomena which attend the propagation of the fresh-water algæ, or, as they are also called, "confervoid algæ." And in examining these, we shall meet with some very interesting changes. But first of all it may be as well, for the benefit of those who have not as yet made themselves acquainted with the plants in question, to give an outline description of the forms in question.

They may be formed of one or of many cells, but in the latter case there is generally very little difference between each. Sometimes, indeed very commonly, the cells are joined end to end; each cell, like other vegetable cells, is composed of a *cell-wall*, or transparent external firm coat (fig. 1, *a*), and of the *cell-contents*, or soft-coloured matter, generally of a green colour, and hence called "chlorophyl" (fig. 1, *b*). Now the cell-wall has no active vitality, this is possessed by the cell-contents; but as these in general would be injured readily, the cell-wall is for their protection, and to increase their solidity. The green cell-contents are disposed in different manners in different plants, and in different times in the same plant. Very commonly there is a colourless transparent body near the centre of the green mass, and this is called the nucleus (fig. 1, *c*; fig. 9, *a*; fig. 12, *α*). This was supposed to be the most active vital part of the cell, and as it is frequently the first to be divided in the process of cell-division, it was considered of essential importance. However, inasmuch as in some cells it is not found at all, and as in them cell-division goes on all the same, some doubt must be entertained in regarding it the essential part of the cell.

Although the arrangement of the cell-contents is variable,

both in the same genera and species, and at different phases in the same species, still in some the form it assumes is very constant for the same phase of its life, particularly in some species. Thus, in *Spirogyra* (fig. 8), it enables us to distinguish the plant at once, because it assumes the form of a spiral band attached to the inner surface of the cell-wall, giving it an exceedingly beautiful appearance. In some confervoids, it is more or less stellate. In the mature cells of the larger *Draparnaldiæ* (fig. 2; a green branching seaweed-like plant, adhering to stones in running streams), it is disposed in a band round the equator of each cell. In many the contents are granular, in some homogeneous, or of uniform consistence. The number of cells in a single plant varies from one up to many hundreds; indeed, as they are all derived from one by its division constantly, there is really no limit, except such as imposed by the time required for it, and by the change of external circumstances, such as the seasons bring, which check the progress of that particular phase.

The most remarkable phenomena of the freshwater algæ are those which are concerned with the multiplication and the reproduction of the species. Broadly, it may be said that every cell of an alga is capable of living, growing, and multiplying, if separated from its neighbours. Still, nature has so arranged that there are cells frequently more especially devoted to this end; and there are times in its life when the process more distinctly goes on. In order to understand these processes, let us for a moment notice the mode in which this process takes place in the true algæ, or seaweeds. In these is to be found the representative of that mode of fertilisation adopted in the higher orders by means of pollen. Now it will be remembered that when the pollen-grain (fig. 3, *a*) falls upon the moist end of the style, namely, the stigma, it produces from certain parts small delicate tubes. These tubes (fig. 3, *b*, *b*) penetrate the substance of the style, passing between their cells (fig. 3, *c*, *c*) to ultimately reach the ovule, or future seed. Acted upon by it in some unknown way, the latter becomes fertilised, and ultimately ripens into the matured seed.

Now, in the true algæ, the representatives of the pollen are called "antherozoids." Each consists of a very minute cell, having one or two fine hairs, or cilia, spring from one end, or one from each end (fig. 4). These cilia have the power of moving in a screw-like manner, whereby the cell is propelled. In the common bladderwrack of our coasts, the process may be readily observed on the bulbous ends of the fronds. If a thin section is made, cavities opening on the exterior will be seen to have been divided. Placed under the microscope in water, branches (fig. 5, *a*) may be seen springing from the wall of the cavities, the

end cell, or antheridia (fig. 5, *b*), of which contains these antherozoids, each of which has a yellow spot in the centre. When the cell-wall breaks up, the latter bodies become free (fig. 5, *c*), and come in contact with the spore, or ovule (fig. 5, *a*). These are also found in the same cavity, among the roots of the branching antheridia. These spores thus become fertilised, and thus the mode resembles very much the enclosed flowers of the common fig.

Let us see how this is carried out in the freshwater algae. We will take a very common instance, *Vaucheria*. It is composed of green filaments; growing in ponds, on damp earth, in ditches—it does not particularly dislike, as most of the algae do, those which are fragrant, but flourishes freely, becoming a tangled mass of very tough fibres on the surface of the water. Although it slightly branches yet it is not jointed, and by this it may be known from almost every form with which it grows. It is indeed only one cell, sometimes attaining many inches in length. The chlorophyl, which is of a deep-green colour, is generally applied to the inner surface of the cell-wall; at one end is found a sort of root of colourless branches, whereby it attaches itself to any objects. The other end of the branches is rather club-shaped, of much darker green, and more dense. Now to those who rise very early in the morning in summer, the following facts may be revealed by nature. A short distance from the club-shaped end (fig. 6, *a*), a line of separation may be observed; after a time, the end of the tube bursts, and the contents now escape (fig. 6, *b*), and assume an oval form, covered with minute vibrating hairs, or cilia, which propel the mass in a rotatory manner in the water (fig. 6, *c*). This may be called a zoospore; perhaps, as it has a number of cilia all over its surface, it may be considered rather as an aggregation of ordinary zoospores.* After a few hours, this zoospore falls to the bottom of the vessel, loses its cilia, its walls become thicker, and soon after, a process arises from it, which is the beginning of another tube. This is a good example of one, perhaps the most common, plan by which these common forms are multiplied. This process is repeated rapidly, and thus this species increases fast.

But this is not the mode which is analogous to that of the seaweed. This is accomplished by the following arrangement:—

At certain parts of the tube, the observer may find elevations springing from it in pairs (fig. 7), one of which is in the form of a hook, or crossier (fig. 7, *a*), the other oval, with or without a stem (fig. 7, *b*). Sometimes on the same stem there are more than one oval process. Now it is in the hook-like process that the

* See paper on "*Volvox*" in this Review, vol. v.

antherozoids are formed, itself is the antheridium (like those before described in the seaweeds), from which they escape in due time. In the other process is matured an oval body (fig. 7, *b*), which represents the ovule, or future seed of the higher orders. An opening in the apex of the process leads down to it, and through this the antherozoids pass to fertilise it. After a time, this ovule escapes by the solution of the wall of the process, and acquires a firm external cell-wall. But unlike the other spore above described, it has no power of motion; though ultimately it grows out, as the other spore, into an elongated tube like its parent.

This plant can be observed in the early spring in a state of fructification, as soon as the frosts have abated; the earlier the better. They can be preserved for observation on the surface of a pot filled with ordinary garden mould, or sand, kept well moistened. If placed in the sun, it will be best to invert a glass over it. It may be found fructifying very well on the shady sides of the furrows in fields.

Thus, then, in this plant we have two forms by which multiplication of the species takes place, one by throwing off a "zoospore," the other by the fertilisation of a cell, which may be called the ovule, or "oospore," or egg-spore.

We will now direct our attention to a third form to be observed in a considerable section of the confervoids; and in doing so, it will be well to watch the whole life-history of one of the plants in which it occurs, as far as at present known. Let us take the common *Spirogyra*, of the family *Zygnemacæ*.

From early spring to late autumn may be found in ponds and pools, the sweeter and clearer the better, a number of filaments of light-green colour, of an inch or two in length. Place these under the microscope, and you will at once recognise the plant by the beautiful green spiral band above-mentioned, to which the plant owes its colour.

There are many species, but they all are very similar in producing the phenomena to be immediately mentioned.

It will next be noticed that it is divided into a number of compartments or cells, joined end to end linearly (fig. 8). In some species there are more than one green band, two or three, like a many-threaded screw. In a few there are two spiral bands, which run in opposite directions.

In the active growth of the plant, it may be observed that the component cells divide into two by sending a process across, or, as some believe, it is effected by a separation of the contents into two equal halves, and then each half throwing a cell-wall around itself. However this may be, the one cell becomes now two. If this continues with rapidity, each cell is much shorter, but after a time the growth of each part goes on, and thus the

filament becomes much longer. This is the ordinary mode by which the growth of filaments in the confervoids is effected. There is one more point of interest in the cell of this plant. In the centre (fig. 9) you may perceive, by a little trouble in "focusing," a transparent colourless body, giving off arms to all parts of the cell, so that it is suspended in the centre. This is the nucleus, and allusion has been made to this body above. Through the centre of this nucleus passes the line of division above described.

But the phenomenon which has attracted so much attention from observers is that which has been called "conjugation," and thence the class of plants in which this takes place (for there are many) have been called the *Conjugatæ*. As the term implies, the process is a joining together of two cells. Ordinarily, it takes place between two cells of two neighbouring filaments; a projection is sent out by each, which meet and unite. During this time, the green spiral band of each cell losing its character, the coils melt together, and then those of one side pass over through the tube of junction into the other cell, mingling with the other green mass; and they then are intimately blended into one large oval green mass, the spore (fig. 10, *a, b*). Soon after this the spore becomes hardened on the exterior, a cell-wall is formed round it, and it is subsequently liberated upon the dissolution of the parent cell; in the course of the next spring it elongates, the contents assume the form of the spiral band, and a cell is thus formed like those of last year; in due time, it divides as before mentioned, and thus a filament of *Spirogyra* is reproduced. In some of the species of this genus, if there is no filament near enough with which to conjugate, the adjoining cells of the same filament conjugate, for a process is throughout from each cell round the joint, and then their contents fuse as above described.

Now what is the exact meaning of this curious occurrence? Opinions vary somewhat. Some see in it the analogue of the fertilisation effected by means of the pollen, and, as above shown, in the *Vaucheria*, only not carried to so complete an extent. Others look upon it as a mere vegetative action, because the contents of the cells involved have no visible difference before nor during conjugation, and that it is rather to sustain the vigour of growth in the plant, which it may lose by repeated division. However this may be, it is at present our safer plan to continue to watch the process, and also to observe whether, in the same plant, any real antherozoids can be found at any time of its life. A careful observation of this plant would be highly interesting to the observer, and doubtless add valuable facts to set at rest this question.

Other changes have been observed in this plant. For instance,

the spiral contents coalesce so as to form a number of globular portions, each leaving *two* cilia at one end, possessing power of movement in the parent cell. When this latter breaks up, these bodies move about freely, and appear like the zoospores of other algæ (fig. 11). Again, instead of the contents resolving themselves into the above form, they become converted into a star-like form, with firm cell-walls. These again, according to Pringsheim, become converted into active moving bodies, whose history has yet to be followed.

Some plants conjugate which only consist of one cell (fig. 12, *a*). The contents of one cell wholly pass over into the other, or remain in the tube of junction, distending it by its growth (fig. 12, *b*). A good example is seen in *Cylindrocystis Brebissonii* (fig. 12).

Now let us watch another of these lower forms which present, as far as at present investigated, a simpler, but more rapid, form than the above in its mode of increase. You may find, in autumn and early spring, at the foot of trees, walls, and palings, green wavy filaments, which readily mat together when taken up (figs. 13-17).

This plant has been called *Prasiola*. Its early condition as a single filament was called *Lyngbya* (fig. 13), and the next stage *Schizogonium* (fig. 14), till the writer pointed out the unity of all these in the *Microscopical Journal* of 1861.

The first stage consists of a green filament divided into many cells, the walls of which are rather thick. The green contents are sometimes uniform, sometimes granular (fig. 13). By constant division of these cells across the filaments, the length of the filament increases. But after a time another form of division arises, each cell dividing at right angles to the former line, so as to become quartered, and to make four new cells (fig. 14), and thus the fibre becomes by the growth of each wider, with the appearance of a colourless line down its centre (fig. 14). After a time, each of these divisions divides again in the quaternary fashion, and a broad strap is produced, which was called *Schizogonium*. By the still further extension of this process, large flat wavy bands are produced, generally wider at one end, retaining, however, in the arrangement of the green cell contents, evidence of its mode of origin. This latter form has been called *Prasiola*. But after a time this strap-shaped frond reverts to the filamentous forms (fig. 15), by the converse of the plan above named. The quaternary division ceases, the simple filamentous is substituted, and these separate from one another, ultimately becoming free; and thus the number of the species is increased. But this is also accomplished upon another plan. One of the cells of the filament sometimes grows three times its original size, and then, separating from the rest

(13, *a*), it appears like a green ball, becoming what has been called a *gonidium*, or spore. If this be kept on a slide in damp air, it will be found after a time to divide in various ways (see fig. 17). Some of these divisions become very small (fig. 17); all, however, after a time revert to the linear or filamentous form.* No zoospores have as yet been found in this alga, although they have been observed in a very closely allied form—namely, the *Ulva*, a saltwater alga.

These confervoid algæ of which we have been speaking exemplify the mode of growth and multiplication in these lower forms of vegetation. All of them, from their simple arrangement, can be readily observed; but in order to observe them continuously, they should be placed in as natural a state as is possible, and that for a considerable period. When brought within doors, they ought, unless living in water, to be placed in a damp situation, covered over by a glass, with as much light as can be obtained; because the reduction of light under cover and in a room is very great. A saucer with damp (not wet) sand, or a piece of sandstone will do well, covered over by a glass; on the sand you can place the specimen, or, if under particular microscopical observation, on a glass slide, ready for instant use.

But it is very important in the aquatic specimens to secure some water from the identical ponds from which they were taken. They are very sensitive to these apparently minute points, and the vessel in which they are kept should not be too deep. To have them ready for instant observation, the specimen should be placed in a live-box made on purpose, having an aperture to admit air; this can be obtained of most opticians. In this manner the conjugation of *Spirogyra* can be observed. *Vaucheria* and *Prasiola* can be kept best on damp sand. It may be mentioned that, of the plants above mentioned, none require an object-glass above $\frac{1}{4}$ -inch focus; generally, $\frac{1}{2}$ -inch object-glass will suffice.

Before closing, it may be well to call the attention of the reader to the circulation to be observed in the cells of *Spirogyra*; it is best noticed near the ends of each cell, and near the cell-wall. Delicate streams are constantly flowing in varying lines, such as may be observed in the hairs of the Nettle, *Achimenes*, &c. and which has been called "cylosis."

To see this well, a high power should be used, either a $\frac{1}{4}$ -inch object-glass, or, even better, a $\frac{1}{8}$ -inch.

* The same mode is seen in the broad bands as shown at fig. 16.

DESCRIPTION OF PLATE.

- FIG. 1. Simple cell—*a*, cell-wall; *b*, green contents; *a*, nucleus.
- ” 2. One of the cells of the frond of *Draparnaldia cruciata*—showing band of chlorophyl at equator.
- ” 3. Pollen on stigma—*a*, pollen-grain; *b, b*, tubes extruded from it; *c*, cells of the stigma. One of the tubes can be seen entering between.
- ” 4. Antherozoids.
- ” 5. *a*, antheridia of bladderwrack; *b*, cells in which the antherozoids are produced; *c*, free antherozoids; *d*, one of the spores.
- ” 6. End of tube of *Vaucheria Ungerii*—*a*, first stage of spore-formation; *b*, escape of spore; *c*, matured spore covered with cilia.
- ” 7. Impregnation of spore of *Vaucheria*—*a*, antherozoids escaping from the antheridial process; *b*, spore enclosed in the other process, which is open to admit the antherozoids.
- ” 8. *Spirogyra quinina*.
- ” 9. One cell of same, showing the stellate nucleus.
- ” 10. Same plants—*a*, conjugation of two filaments; *b*, free spore.
- ” 11. Zoospore—formation in same.
- ” 12. *Cylindrocystis Brebissonii*—*a* shows nucleus of simple cell; *b*, two cells, having conjugated, have formed a spore.
- ” 13. *Lyngbya*—*a*, gonidium.
- ” 14. Same, growing.
- ” 15. Same, recurring to filamentous form.
- ” 16. Same, throwing off cells which are dividing.
- ” 17. Divisions of the gonidium at 14, *a*.

THE GEOLOGY OF SINAI.

BY THE REV. E. W. HOLLAND, M.A.

FROM our very childhood we have been taught to regard the Peninsula of Sinai as a hallowed land, yielding the palm of sanctity to Palestine alone. As the scene of the giving of the Law; as the natural cradle selected by God for the development and growth of His Chosen People into an independent nation; as the region to which the Prophet Elijah directed his steps in his memorable flight from the cruel Jezebel; as the probable abode of the Apostle St. Paul, when he withdrew to Arabia after his miraculous conversion, it is indeed a land full of sacred associations. But, apart from its great Biblical interest, it is in many other respects one of the most remarkable districts on the face of the earth.

Its geographical position has rendered it the connecting link between Asia and Africa. In the rocks which compose its mountains; in the shells which strew its northern and southern shores; in its scanty fauna and flora, we may trace that bond of union which connects the physical characteristics of the great African and Asiatic continents. Bounded also as it is on the north by the land of Palestine and the Mediterranean Sea; separated from Egypt on the west by the narrow strip of desert which forms the Isthmus of Suez, and from the once powerful kingdom of Arabia on the east by the depression of the Wady el-Arabah; encircled on the south by the two arms of the Red Sea, now known by the names of the Gulf of Akaba and the Gulf of Suez, each of which has at different periods formed a highway for commerce between the Indian Ocean and the Northern world, the Peninsula of Sinai has long maintained a degree of contact with civilisation which the barren character of its dreary wilderness would otherwise have denied it, and it has played its part in the rise and fall of some of the greatest nations of the East.

The peculiar physical features of the peninsula, no less than its geographical position, have marked it out as a country of note. To them it has owed a large extent of the influence which it has exerted at different periods over mankind; and it cannot but prove a subject of deep interest to trace out their leading characteristics and origin.

It is a country in the history of which geology occupies a more than usually prominent position. Being essentially a desert region, yet at the same time almost entirely destitute of that mantle of sand which has enveloped and concealed the natural features of so large a portion of the African deserts, it owes its grandeur, no less than its barrenness, to the nature of the rocks of which it is composed. It is difficult for those who live in such a land as ours, which owes its charms to its luxuriant vegetation, to conceive how a country which is described as being almost entirely devoid of vegetation, can have any pretensions to beauty. Yet, apart from all its sacred associations, I know of no country which impresses itself more vividly upon the senses than the southern portion of the Peninsula of Sinai. "It combines the three grand features of earthly scenery—the sea, the desert, and the mountains." The lack of vegetation is compensated for by the bright colours of its rocks, which, when lighted up by the rising or setting sun, produce an effect the beauty of which it is impossible to describe; the want of rivers and lakes is supplied by the frequent views of the deep-blue sea, which present themselves from almost every point in the Sinaitic range; and the wild grandeur of the mountains, ever varying in form and structure, dispels the monotony which the absence of trees would otherwise beget.

The northern portion of the peninsula, which is generally known by the name of the Desert of et-Tih, or "the Wanderings," is very different in its character from the southern. Here the granitic and sandstone rocks give way to limestones; and the mountains lose their bright colouring and fantastic forms, and assume a tabular outline and glaring whiteness, of which the eyes of the traveller soon weary.

The hydrography no less than the geology of these two portions of the peninsula, naturally leads us to separate the one from the other, and describe them as independent districts. This course I shall now follow. But in order to render my description of the country intelligible, I must first explain the meaning of the Arab word "Wady," which I shall be compelled frequently to use, since there is no English word which exactly corresponds to the idea expressed by it. The word "valley," perhaps, most nearly expresses it; yet even that word, comprehensive as it is, does not include the full meaning of the Arab "wady," which is applied equally to describe the broad valley of several miles in width; or the narrow course of the mountain torrent with its rugged bed, and overhanging cliffs, which scarce permit the loaded camel to force its way between them; or again the slight depression in a plain, the depth of which may barely suffice to afford a channel for its drainage. The northern desert of the Tih is still but little known; in

fact, a large portion of it yet remains entirely unexplored. A few travellers have crossed it from different points, and have published rough sketches of the routes they have taken; but we have not sufficient data for any accurate description of it. I shall therefore confine myself to a few general remarks upon its character, grounded chiefly upon observations of my own during two hurried journeys across it—the first undertaken in 1861, when I rode from the southern pass of Rakineh in the Jebel et-Tih, by the castle of Nūkhī, and Beersheba, to Hebron; the second in 1865, when I traversed the desert on foot from Akaba to Suez, following the course of the Hadj route, or road taken by the pilgrims from Egypt to Mecca.

This desert may be briefly described as consisting of an extensive plateau of limestone rock, supported and enclosed on the south by a long range of mountains, which, commencing on the west, runs for a distance of nearly sixty miles almost parallel to the Gulf of Suez, under the name of Jebel er-Rāhah; and then changing its name to that of Jebel et-Tih, and circling round towards the east, shapes its course in the form of a festoon, suspended from the heads of the two gulfs of Suez and Akaba. Throughout its whole course, this range presents a singularly unbroken and tabular outline, especially the western portion of it; the eastern portion appears to be broken up into several almost parallel ranges, as it approaches Akaba.

The plateau of the Tih is bounded on the east, and separated from the valley of the Arabah, by the range of mountains which stretches down from the Dead Sea to the head of the Gulf of Akaba.

The best maps represent the north-east portion of this plateau as being drained by wadies flowing into the Arabah, which conveys their waters to the Dead Sea. But the whole of the remaining portion is drained by the numerous branches of the Wady el-Arish, which empties itself into the Mediterranean Sea, about fifty miles south of Gaza, and which formed the ancient boundary between Egypt and Palestine, under the name of the River of Egypt. Its surface presents a succession of large undulating plains, studded with low mountain ranges, which appear generally to run from south to north; its rocks are composed chiefly of calcareous limestone, which in some places is very rich in Echinodermata and other fossils; its plains are hard and pebbly, often covered with numerous flints of dark colour, which contrast strangely with the glaring whiteness of its mountains. The southern and more elevated portion of this plateau is singularly barren, but as it slopes northwards, and the branches of the Wady el-Arish increase in number and size, the vegetation increases in proportion. The fall being small, the water often stands in the broad shallow wadies for a con-

siderable time, and leaves large tracts of alluvial deposit, which, if properly cultivated, would yield an abundant harvest. I have seen several acres of this soil ploughed up for corn within a few miles of Nûkhl, though in consequence of the dearth of rain it had not been sown; from this point northwards every day's journey shows a visible increase in the amount of vegetation, and before reaching the ruins of el-Abdeh, the country assumes the character of downs, the low-rounded hills being covered with tufts of grass: the wadies in this portion of the desert abound in the spring with anemones and other flowers, some of which the Englishman may recognise as garden friends in his own country; and the ruins of walls built across the watercourses to support terraces, and heaps of loose stones gathered from the fields, give evidence of cultivation having been carried on in ancient times to a considerable extent. This district of the Tih has evidently changed much since the commencement of our era. Ruins of considerable towns mark the former existence of a large population, where now a few wandering hordes of Bedouins are alone to be found. The desert has again claimed as its own the land that was formerly rescued from its grasp. Unchecked, it still advances, slowly indeed here, but more rapidly and steadily along the coast of the Mediterranean and on the borders of the Isthmus of Suez, under the resistless influence of overwhelming sand-drifts. Of the supply of water in the desert of the Tih, I cannot speak with certainty; in the southern portion it appears to be very scanty, but is, no doubt, much more abundant in the more mountainous districts on the north-east, and in the basin of the Wady el-Arish.

We turn now to the southern division of the peninsula, which includes the granitic and sandstone districts, and the large plains which extend along the shore of the Gulf of Suez—that is, the whole of the country to the south of the mountain ranges of Jebel er-Râhah and Jebel et-Tih. The limestone of the Tih is separated from the mountains of the Tûr (the name given by the Arabs to the mountainous district in the south of the peninsula) by a belt of sand called the Debbet-er-Ramleh, which stretches across nearly the whole breadth of the peninsula; and this is the only tract of sand which is to be found in this district. My readers will have learned by this time that a desert is not necessarily a level expanse of sand, almost entirely devoid of vegetation. Such indeed are many of the deserts of Africa, perfect “seas” of sand, as they are sometimes called by the natives; but this popular idea of a desert is for the most part a very erroneous one, and has been the cause of great misunderstanding as to the features of “the Desert of Sinai.” The district of the Tûr is essentially a mountainous region, so much so, that one of the great

difficulties which travellers have met with has been to find in it a plain or valley sufficiently large to contain the tents of the Israelite host. It has been called "the Alps unclothed;" and next to the wild grandeur of its mountains, the most striking peculiarity that meets the eye of the traveller who has just left the rich valley of the Nile is the absence of vegetation, and the barrenness of its rocks. A very remarkable succession of plains extends along the whole of the western coast of the peninsula from Suez to the southernmost point of Ras Mohammed. The most northern of these plains, the ancient wilderness of Etham, or Shur, is about seventy miles long, and from twelve to fifteen miles broad, being bounded on the east by the range of Jebel er-Râhah, which has already been described. This plain may be said to extend as far south as Jebel Hummâm, a ridge of calcareous limestone, which forms a bold promontory, cutting off all farther advance along the shore; about ten miles north of this point, however, the sandstone hills between Wady Ghurundel and the spring of Abu Suweirah interrupt the progress of the plain for a time. The traveller who is journeying southward along the coast is forced to make a circuit round the back of Jebel Hummâm, but south of this mountain he again arrives at a succession of smaller plains, three in number, which together occupy a space of about thirty miles in length, being separated from one another by low spurs of limestone, which run down so close to the sea as barely to leave sufficient room for a caravan to pass round them. The first of these three plains was that occupied by the Israelites during their encampment by the Red Sea which is mentioned in Numbers xxxiii. 10; the two latter, perhaps, were both included in the Wilderness of Sin. The sandstone hills which enclose the lower portion of Wady Feiran form a barrier which separates these plains from that of el-Kâa, a plain nearly ninety miles in length, running unbroken by any mountain until it reaches the southern promontory of Ras Mohammed; the northern portion of it, however, is separated from the sea by the range of Jebel Hemam. These shore-plains are by no means destitute of vegetation. That between Suez and Jebel Hummâm most travellers have described as being especially barren; but this has been because they have taken the upper road; had they journeyed along the coast, their account of it would have been very different. The upper portion of the plain, i.e. the portion nearest to the range of Jebel er-Râhah, is certainly sterile enough; but along the coast a line of low hills of sand is found, which intercept the drainage to the sea, and have caused the formation of a considerable tract of alluvial deposit, affording good pasturage for the camels of the Terrabein Arabs, and abounding with thickets of tamarisks and other bushes. The three smaller plains which lie between Jebel Hummâm and Wady

Feiran are evidently flooded more or less during the winter months by the flow of water down the numerous wadies which open out upon them, and the less elevated parts are studded with numerous shrubs and herbs. The northern portion of the large plain of el-Kâa receives the whole of the drainage from the western side of Serbal, which, aided by some local springs, gives birth, near the little seaport of Tor, to an oasis which can boast of the richest palm-groves in the peninsula. The southern portion of this plain is more elevated, and consequently more barren; though even here occasional depressions occur along the coast, which afford pasture-grounds for the flocks of the few Arabs who live in the neighbouring mountains.

There are traces of extensive denudation in some of these shore-plains: the level of the old wilderness of Etham was evidently at one time some five or six feet higher than it is at the present time, and the huge boulders which strew the northern portion of it bear testimony to its having formed at some period a seabed.

The general character of the shore-plains is that of a bed of hard gravel, often covered with a coating of dark flints, which not unfrequently present a curiously wrinkled surface, caused by the drifting sand.

The granitic district forms a centre round which are gathered the other rocks which are found in the southern division of Sinai. It constitutes, as it were, the backbone of the peninsula, and is especially interesting as containing Jebel Mûsa, now generally recognised as the true Mount Sinai, and other mountains which have at various times been rival claimants to that honour, or to which tradition has attached some sacred association.

This district consists of rugged masses of mountains heaped together in such intricate confusion as to baffle all attempt at accurate description. The basins of the various wadies which drain its waters run into one another in such a manner that it is difficult to master the puzzle they present, or to grasp any definite idea of the nature of the district viewed as a whole. The wadies, deeply cut by the winter torrents through the rocky barriers which hem them in, wind and course in every direction. The mountains, it has been said, look as if "they were an ocean of lava which, whilst its waves were running mountains high, had suddenly stood still." It is only when he has mounted to the summit of one of the highest central peaks, whence he can look down upon the minor ranges dwarfed by a somewhat distant view, and can see the larger masses arranging themselves into more distinct groups, that the traveller really comprehends the leading features of the country. Mount St. Catherine is, I believe, the highest peak in the whole

Peninsula of Sinai, being, as proved by my aneroid, 8,063 feet in height, while Jebel Um Shaumer, which has long been regarded as the highest, is only 8,030. This mountain therefore, not only on account of its being the most lofty, but also from its central position, shall be selected as a standing-point from which to take a general view of the granitic district.

Looking southwards the mountains are seen to form one long ridge, which extends to the very southernmost point of the peninsula: perhaps the shape of the mountains may be thought almost too irregular to take the name of a ridge, lofty and massive spurs being thrust out on either side, and bold irregular peaks frequently interrupting their line; but, speaking in general terms, the watershed may be described as running along a central line drawn through the south of the peninsula, from Mount St. Catherine to Ras Mohammed, and from this line the wadies appear to find their way more directly to the sea on either side than is the case farther to the north. The only mountain of any fame in this region is that of Um Shaumer, which lies on the south-west, and which has generally been described as shrouded in mystery; why I know not, except it be that travellers have been more ready to listen to the stories of the Arabs concerning a mountain which has seldom been visited. I myself must own to having been somewhat disappointed, after all that I heard about it, in finding in it no mystery to unravel. Eight hours' walk from the convent of St. Catherine landed me on its summit; its ascent was not more difficult than that of Jebel Serbal; and the mysterious noises that my Arab tried to make me believe that I had heard were easily traced to a rock set in motion by a herd of ibex which bounded up the mountain before me.

The northern portion of the granitic district is more worthy of our notice. No mountain group indeed stands prominently forward on the east, but on the north-west is seen the massive cluster of Jebel Serbal, which, if not the loftiest, is certainly the most imposing-looking mountain in the whole peninsula. We cannot, indeed, from the position in which we are viewing it, see its various peaks; but it owes its grandeur to its massive form no less than to its jagged outline, and with its bold spurs and deeply-cut wadies thrust down on the one side to the Wady Feiran, and on the other to the broad plain of el-Kâa, it stands unrivalled as the monarch of Sinaitic mountains. One cannot wonder that tradition has fixed upon it as the scene of the giving of the Law; but a closer inspection of it proves the fallacy of such tradition. It stands in reality far removed from the plain of el-Kâa, separated from it by a broad strip of mountainous ground: it is a mountain which could not by any possibility be surrounded by bounds, either on the one side or on the

other. The Wady Feiran, in which the supporters of its claims assert that the encampment of the Israelites must have been placed, is confined and narrow; the wadies which flow into Wady Feiran from Jebel Serbal are still less suitable for a large encampment. In no way does this mountain seem to agree with the account which we have in the Bible of Mount Sinai. Jebel Mûsa alone, of all the mountains of the peninsula, appears to answer the requirements of the Bible narrative; that mountain alone, which we look down upon from the summit of Mount St. Catherine, lying to the north-east, close beneath our feet, stands apart from the mountains which surround it, and rears up its sides so precipitously, that it may indeed be described as a mountain "that can be touched." To the north of it extends a broad plain, the plain of er-Râhah, enclosed by mountains on either side, and forming a natural amphitheatre, where "the people could remove and stand afar off," and listen to the wondrous voice of God, which came forth from the mountain before them. Two lofty peaks, with a deep cleft between them, immediately overhang and face this plain. These form the well-known Râs Sufsâfeh. On the opposite side of the mountain rises a yet higher peak, crowned with a little chapel, and known as the summit of Jebel Mûsa; yet this peak stands so far back that it is not visible from any portion of the plain of er-Râhah. The top of the mountain between the several peaks contains a fertile basin, which may easily be reached from three different sides of the mountain, the easiest road being that which leads up from the plain, at the point where it flows into the Wady Es-Sheikh; from this point I have reached the basin with ease in three-quarters of an hour. The Wady Shueib on the one side, in which stands the famous convent of St. Catherine, the Wady Bostân on the other—rather than the Wady Leja, as has generally been stated—separate this mountain from those on either side of it; and though it is not so lofty as other mountains around it, its isolated position and precipitous sides rising boldly from the plain at its foot, render its appearance far more imposing than even that of Mount St. Catherine, which towers above it, but loses its height to the eye, owing to its more confined position and more gradual ascent.

The granitic district is the best watered and the most fertile portion of the peninsula. Having the greatest elevation, it naturally receives the largest amount of rain, which, owing to the impermeable nature of its rocks, and the frequent occurrence of basins, such as is found on the summit of Jebel Mûsa, does not always flow off so quickly as in the other districts. There are indeed few perennial streams to be found, either here or elsewhere, throughout Sinai; the wadies form huge stone-drains, which convey the water rapidly away to the sea; a thick stratum

of stones and rubble generally fills the lower portion of their beds, and under this the water flows unseen, except in times of floods, or when, as in Wady Feiran, or in Wady Hibrân, it is forced to the surface by rocky barriers narrowing and contracting their courses. It is not, however, till one wanders over the mountain on foot, or visits the Arab encampments towards evening, and sees the bundles of herbs which the men and children bring home for the camels and goats, that one can form any just estimation of the amount of vegetation which the rocks conceal. The mere passer-by also is apt to overlook the quantity of pasturage afforded by many of the wadies; this evidently varies much, according to the season of the year, and the amount of rain which falls in the winter months, and it is sometimes increased in an almost miraculous manner by the heavy rains accompanying thunderstorms at other times.

So far I have spoken only of the rocks of this central district under the general term "granitic;" I will now endeavour to describe their geological features more accurately. They appear to be principally composed of syenite, especially in the more elevated districts, such as Mount St. Catharine, Jebel Mûsa, and Jebel Serbal; but hornblendic, quartzose, and porphyritic rocks are not uncommon. The mountains are frequently seamed from top to bottom with veins of porphyry, greenstone, and basalt, which gives them a peculiar striped appearance, and adds much to their beauty. This is especially remarkable on the east of the well-known Wady Mokatteb, and in some of the wadies on the road between Jebel Mûsa and Akaba. Felspar and porphyry occur largely near Ras Mohammed, and gneiss and mica-schist are found in the neighbourhood of Wady Mokatteb. The rock of Moses, which lies in the Wady Leja, near Jebel Mûsa, and which tradition says followed the Children of Israel in their wanderings through the desert, is a mass of granite, with crystals of white and pink felspar and quartz, across which runs diagonally a vein of pure felspar, containing ten or twelve cracks in its surface, which are said to be the mouths from which the water flowed for the different tribes. This rock is exactly fourteen feet in height and seventeen feet in breadth at its broadest part. The veins which seam the mountains have frequently been described as rich in metallic ores. This appears, however, to be a mistake. Cretaceous limestone, with numerous bands of flints, occurs in large masses in the north-west of the Tûr district, in conjunction with sandstone, and also on the north-west of Jebel Serbal: at the latter spot nummulitic limestone also occurs; near Tor and Ras Mohammed a limestone of a more recent formation is found.

In several parts of the peninsula the granitic mountains are capped by a stratum of sandstone of considerable thickness,

which gives them a peculiar castellated appearance. The stratification of this sandstone appears always to be perfectly horizontal, and there can therefore be little doubt that it was deposited after the upheaval of the igneous rocks; an additional proof that this was the case is also afforded by the absence of change in the nature of the sandstone, whenever it is found in close proximity to the granite. An equal absence of change is also to be observed where the limestone occurs in contact with the same rocks. The limestone apparently was deposited previously to the sandstone; an enormous denudation, however, must have taken place before the deposition of the latter; for masses of limestone, showing no signs of upheaval, occasionally occur at a much higher level than the sandstone; the thickness of the stratum of sandstone which was subsequently deposited must have exceeded 2,000 feet. Whether the denudation that has since taken place has been caused by terrestrial or marine agency, is a question that has yet to be solved. Considerable masses of sandstone occurring which contain a large percentage of calcareous matter render it probable that that rock was in process of formation while the limestone was still undergoing disintegration. Some slight upheaval of the igneous rocks appears to have taken place between the deposition of the limestone and the sandstone rocks, since the stratification of the former occasionally appears slightly disturbed, while that of the latter, which rests upon it, retains its horizontal position; but this upheaval must have been very gradual and local. The only traces of active volcanic agency which are now to be found in the peninsula are the boiling sulphur-springs and hot caves of Jebel Hummâm, the traditional baths of King Pharaoh, and two warm springs which burst from the foot of a hill a little to the north of Tor, and are held in great repute by the Arabs for their medicinal powers.

The sandstone formation is especially interesting, as having formed the great mining district of the ancient Egyptians in Sinai, as is attested by the numerous tablets of hieroglyphics which are found at Wady Mughâra, and Serâbit-el-Kâdim. The aspect of the sandstone mountains is very different to that of the limestone and granite mountains. The limestone mountains present a tubular summit and steep sloping sides; the granite mountains may be recognised almost at any distance by their bold jagged peaks; the sandstone mountains form with their sides a series of steps, and are frequently pyramidal in shape. The sandstone is generally of a reddish ferruginous colour, though its surface is for the most part covered with a dark brown oxide of iron, which is apparently formed by the decomposition of the rock. The Egyptian mines which have as yet been discovered are all turquoise mines, with the exception,

perhaps, of those in Wady Nusb, which I have not visited. The turquoise appear to run more or less in veins, but their occurrence seems to be very uncertain; and it is difficult to understand how it could have been worth while for the Egyptians to carry on such extensive mining operations, unless the mines formerly yielded a more abundant return for labour than they do at the present day. Most travellers who have visited Serâbit-el-Kâdim have described two heaps of copper-slag lying on each side of the ruined temple on the summit of that mountain, and many have written of the copper-mines of Serâbit-el-Kâdim and Wady Mughâra. Specimens which have been brought from these supposed slag-heaps prove, however, most clearly that they are not slag-heaps at all, but merely a natural impure ore of iron and manganese; nor does there appear to be any copper at either spot, excepting a thin film of silicate which occurs at Serâbit-el-Kâdim. I have, however, in my possession some specimens of undoubted copper-slag from some heaps which Major MacDonald found near the west coast in Wady Shellal; and also some specimens of malachite and carbonate of copper, which prove not only that copper exists in the peninsula, but that it has been worked and smelted.

In the neighbourhood of Wady Mughâra and Wady Mokatteb beds of siliceous brown iron ore occur in the sandstone rock, which appear to have been worked at some period. Stone hammers and flakes of flint are found round this spot, which must either have been used by the captives of the Egyptians, who would appear to have been condemned to work in their mines, or by a later race—perhaps by the authors of the famous Sinaitic inscriptions, whom I believe further research will prove to have been a colony of the Nabathæans, established in the more fertile neighbourhood of Jebel Serbal, for the purpose of working the mines in the Peninsula of Sinai, between the years B.C. 200 and A.D. 200.

Considerable beds of beautifully crystallised salt are found in the sandstone district, as clear and white as it is possible for salt to be; no fossil organisms, however, seem as yet to have been found, except a portion of the stem of a plant, and a few other vegetable remains. The geological changes that have taken place in the Peninsula of Sinai in historic times I believe to have been very small. Of the agencies which are now at work in modifying the surface of the country, the chemical action of the atmosphere would seem to play an important part in destroying the ferruginous cement, which binds the particles of the sandstone together, and thus decomposing the rock. The wind no doubt, bearing with it the drifting sand, also aids in the work of destruction. Frost and rain are perhaps the most powerful agents in the more elevated portions of the peninsula.

In the winter months the higher ranges of mountains are covered with snow, and I have even seen, at the foot of Jebel Mûsa, a basin of water frozen over after six o'clock in the morning, at the very end of March. The traveller often suffers more from the cold of the nights than he does from the heat of the days. During December and January a large fall of rain generally takes place, and, owing to the nakedness of the mountains and the steepness of the wadies, the torrents acquire enormous power, as is testified by the size of the boulders which are seen in their courses. The perennial streams and springs are too few and feeble to effect much change. The organic agencies are hardly worthy of mention, with the exception of the coral, which must tend much to alter the nature of the coast-line; yet the scanty supply of vegetation which clothes the wadies and plains aids in collecting and binding together the drifting sand and alluvial deposits.

The question of the raised beaches, especially at the head of the Gulf of Suez, is one of great interest. I am inclined to believe that the shore has not risen to any great extent since the time of the Exodus, and that the flooding of the Bitter Lakes in the Isthmus of Suez has been effected at different periods by the cutting of artificial canals. The explorations of the French engineers engaged in making the Suez Canal will perhaps aid in solving this problem. If, however, it be proved that a considerable elevation of the coast has taken place since the Exodus, unless we can prove that a subsequent degradation of the shore-plains has also occurred, we shall have to alter our opinions regarding the route taken by the Israelites on their march to Sinai; since large portions of these plains are now but a few feet only above the level of the sea, and would therefore before their elevation have been submerged. I feel confident, however, that future explorations in the Peninsula of Sinai will tend not to weaken but to strengthen our belief in the sacred narrative. And I trust that, before long, a more careful survey of the country may be made, which no doubt will place in our hands fresh proofs of the truth of that history, and will make us better acquainted with the features of a country which stands almost without a rival in its interest for mankind.

THE PLANET MARS IN JANUARY 1867.

By RICHARD A. PROCTOR, B.A., F.R.A.S.

(*Author of "Saturn and its System," &c.*)

OF the planets within the orbit of Uranus, Mars appears, at first sight, to be the least inviting object of study to the observer possessed of moderate telescopic power. Jupiter, from the noble aspect of his disc, and the ever-varying configurations of his attendant orbs, is among the most charming of telescopic objects. With a telescope of somewhat higher power than that available for the study of the larger planet, Saturn bears away from him the palm for splendour of appearance, and for the wonderful yet symmetrical gorgeousness of his attendant system. Venus and Mercury, in a lesser degree, although both are "difficult" objects, yet attract the young observer, by the lowness of the powers with which their varying phases are made conspicuously visible. Mars, on the other hand, presents no features which a telescope of very low power can reveal; and even with a telescope of considerable power, some patience, combined with skill and practice in observation, are required to enable the observer to interpret satisfactorily the phenomena presented to him. Yet it must not be forgotten that, of all the planets, Mars is that which is in reality the most favourably situated for telescopic research; or, rather, it would not be saying too much to assert that Mars is the only object in the heavens whose examination is capable of supplying an answer to some of the questions which most largely interest the thoughtful mind. With the telescopes yet constructed, indeed, it were too much to hope that much exact information as to the physical condition of Mars should be gleaned, under whatever circumstances the planet may be observed; nor would the simple increase of magnifying power, which the past history of the telescope leads us to hope for and expect, conduce greatly to the attainment of the above-named object. But it does not seem too much to hope that some day (haply not so far distant) the lesson taught us by Professor Smyth's Teneriffe experiment will be appreciated as it deserves. Then a telescope surpassing in power any yet constructed shall be placed where alone the power of such an instrument can be

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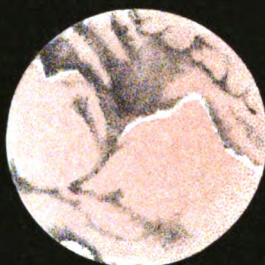
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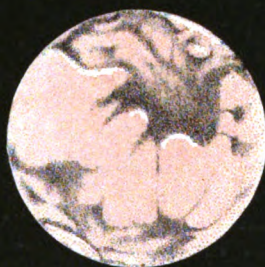
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efficiently exerted—where Newton long since told men that such an instrument should be placed—far above those denser atmospheric strata whose disturbances never cease, and are magnified and aggravated by every increase of telescopic power. When this is done, we may look in Mars for that which has long been sought for fruitlessly upon the lunar surface—the signs of life, of change, of progress, of decay. In one point, indeed, Mars has already supplied such evidence; since, as we shall presently see, he exhibits, in regular succession, appearances corresponding to changes well known to be taking place regularly upon our earth.

There is another circumstance which tends to heighten the interest with which the astronomer regards this small planet. Its motions, watched for many long years by Tycho Brahe, and studied for twenty years by the ingenious Kepler, were the means of overthrowing for ever the elaborate system of errors and hypotheses known as Ptolemaic astronomy. They afforded also to Newton the first hint on which he founded the law of universal gravitation. The figure of Mars' orbit, and the relation which that orbit bears to the orbit of our earth, rendered the planet the most fitting, one may almost say the only fitting, member of the solar system for the purposes Kepler had in view.

As it is necessary for the right understanding of the appearances presented by Mars at successive returns to opposition that the nature of his orbit should be rightly understood, I shall solicit the reader's patience while I run as briefly as possible through the points of chief importance. This is the more necessary because no popular work on astronomy (that I at least have ever met with) presents with any approach to accuracy this very important feature of the solar system. Even that admirable and interesting work, Guillemin's "Heavens," deals very inadequately, though at some length, with this question.

In fig. 1, $E_1E_2E_3E_4$ represents the orbit of the earth, and $M_1M_2M_3M_4$ that of Mars. M is the perihelion of Mars' orbit, which, it will be observed, is noticeably eccentric (C_1 , the centre, being 13,000,000 miles from the sun); E is the perihelion of the earth's less eccentric orbit, whose centre is at C_2 . The arrows indicate the direction in which both planets revolve around the sun. The plane of Mars' orbit is inclined at an angle of $1^\circ 51' 5''$ to that of the earth, the points marked Ω and ϖ being those at which the orbit of Mars intersects the plane of the earth's orbit; at M and M' Mars attains his greatest distance from the plane of the earth's orbit, the short arrow indicating, as nearly as possible, on the scale of our figure, the distance at which Mars is above and below the plane of the ecliptic at these two

points respectively. Of the absolute dimensions of the two orbits, it will be sufficient to say that the greatest and least distances of the earth from the sun are respectively 93,190,000 and 90,110,000 miles, the greatest and least distances of Mars 152,670,000 and 126,620,000 miles.

Mars takes 686.979 days in completing one circuit around the sun; thus it is easily calculated that the mean interval between successive oppositions is 779.836 days. Owing, however, to the great eccentricity of Mars' orbit, and the consequent considerable variation in the rate of his motion around the sun, the successive synodical revolutions of the two planets vary in length, being greater or less according as opposition occurs near perihelion or near aphelion respectively. The positions of the oppositions from 1856 to 1871, marked in fig. 1, will be sufficient to indicate this. The line of opposition travels round in the order of the signs. After travelling *twice* round the zodiac, the line falls very nearly in the position it had at starting, such double revolution occupying thirty-three years, in the course of which Mars has been fifteen times in opposition.

It will be obvious, from a moment's inspection of fig. 1, that the appearance presented by Mars, when in opposition near M,* must be very different to that presented when he is in opposition near M': the distance of Mars in the former case being less than his distance in the latter case in the proportion of about 19 to 37; or, in miles, the former distance is 34,140,000, the latter 61,860,000 miles. Hence arise variations in the magnitude of the disc presented by the planet; and since Mars in perihelion is more brilliantly illuminated than when in aphelion, his apparent brightness is yet further increased. By the first cause his brightness is increased as the squares of the numbers 37 and 19, and by the second as the squares of the numbers 41 and 34; or, on the whole, his brightness, when in opposition in perihelion, is about five times as great as his brightness at opposition in aphelion. So bright does he appear, when the first conditions are nearly approximated to, that his appearance has caused alarm to the uneducated. Theoretically, indeed, he ought to appear brighter at such times than Jupiter himself at his brightest, since the disc of Mars, smaller than that of Jupiter in the ratio of 24 to 49, is more brilliantly illuminated in the greater ratio of 472 to 126, so that Mars should appear brighter than Jupiter in the ratio of about 5 to 3. Jupiter,

* Owing to the eccentricity of the earth's orbit, and the circumstance that the perihelia of the two orbits have different positions, M is not absolutely the point of Mars' orbit which lies nearest to the earth's orbit. The point of nearest approach *precedes* M by a small arc, which (were it worth while) it would be easy to calculate.

however, sends us more light, probably because his atmosphere bears large belts and masses of clouds capable of reflecting light very perfectly, and also preventing the loss of light which would accrue in the double passage through the planet's atmosphere. The studies of our leading astronomers and physicists leave little doubt that the light by which we see Mars has suffered diminution in this way to a very considerable extent.

Oppositions of Mars near perihelion occur at intervals of fifteen and seventeen years successively. Sometimes it happens, as in 1860 and 1862, that two successive oppositions occur at nearly equal distances from perihelion; it follows that the next opposition near perihelion (in 1877) will fall midway between these positions, or very much nearer perihelion than either of the two others; in other words, Mars will be very favourably situated for observation in 1877. Much of the superiority of perihelion-oppositions is, however, lost in our northern latitudes, since these oppositions occur in August; and the sun being high by day, it follows, of course, that the ecliptic (near which Mars is always situate) is low by night. On the other hand, it is clear from the figure that, if Mars is in opposition in midwinter, when of course he has a considerable altitude at night, he is too near aphelion to be favourably seen. On the whole, it follows that the most favourable position for Mars to come to opposition in is towards autumn (when he is near 3 of fig. 1). At this season, while not very far from perihelion, he attains an altitude of from 55° to 60° on the meridian. Such an opposition took place in 1862, when very admirable views of Mars were obtained by Messrs. Dawes, Lockyer, and Phillips, and by others of our best observers. The opposition of 1864 was also a very favourable one.

But another circumstance remains to be considered. The planet, rotating on an axis considerably inclined to the orbit of motion (and also to the ecliptic), presents at different seasons different aspects, not only with reference to the sun but also to the observer on earth. At one time his north pole is bowed down towards the sun, at another his south pole; and the same relations, only in a somewhat more complex order, are maintained with respect to the earth. If, then, the astronomer would rightly study the peculiarities of our neighbour Mars, he must examine the planet at oppositions occurring in every part of his orbit. On this account, therefore, the opposition of Mars, which takes place on January 10, 1867, although occurring when he is not very far from aphelion, is not to be on that account neglected. It happens, indeed, that, for the study of the *northern* hemisphere of Mars, this opposition occurs, on the whole (that is, combining considerations of distance, altitude,

and extent of presentation of the northern hemisphere), in about the most favourable part of Mars' orbit.

As respects the inclination of Mars' axis to the plane of his orbit, and the other elements on which his seasons and the appearance he presents to us depend, we have the determinations of Sir W. Herschel. He estimated that the Martial spring equinoctial point was situated (in 1787) in longitude $79^{\circ} 28'$ (the longitude of M_1 in the figure is 78°), the obliquity of the Martial ecliptic $28^{\circ} 42'$, and the inclination of Mars' equator to the earth's orbit $30^{\circ} 18''$. I fear it will be considered somewhat rash to impugn results obtained by Sir W. Herschel. Standing, as he does, in the very foremost rank among observers, and *facile princeps* as an *interpreter* of observations, astronomers justly look on his opinions almost as laws. Yet I think, if we consider the nature of the observation, and the character of the instruments used by Herschel, we must recognise the fact that he attributed to his results an exactness they were not capable of attaining to. The pictures of Mars given by Herschel are sufficient to show that the instrument he used was far inferior in defining power to those with which Delarue, Dawes, Lockyer, and Phillips have examined the planet. Now, let us see on what indications furnished by Mars (thus viewed) Herschel founded the determinations above recorded. Referring to the paper in the *Philosophical Transactions*,* we find that the indications he trusted to were the motions of spots across Mars, and the appearance or disappearance of certain bright spots near the Martial poles. In fact, from the nature of the case, it is obvious that no other sort of evidence was available. The necessary observations were repeated at intervals, as the weather permitted, and carefully reduced (on just mathematical principles) in accordance with the motions of Mars and the earth in their respective orbits. Now, if we consider the minuteness of the disc presented by Mars, the variable appearance of the spots and points upon his surface, and the extreme difficulty of assigning, with any approach to exactness, the period or place at which a spot or point becomes visible on the edge of a rotating sphere, even when such sphere is distinctly (and permanently) marked, we shall see that, even with the best modern instruments, it would be impossible to determine the inclination of Mars' axis within two or three degrees, or the place of his vernal equinox within seven or eight degrees. Those who are best able to appreciate Herschel's work as an astronomer will be precisely those who will most clearly recognise the difficulty of the problem he attacked. It is to be wished that some of our modern observers would re-examine the subject. That very

* *Phil. Trans.* 1784, p. 24 1.

little attention has been bestowed upon it by writers on astronomy will be evident from this,—the numbers given by Herschel are repeated not only without comment, but even without those changes which the variations in the orbit of the planet render necessary. Given the position of Mars' axis with respect to his orbit, and the position of his orbit with respect to the earth's, then the position of his axis with respect to the earth's orbit follows at once. If either of the data vary, the result will vary. Now, the second datum has varied largely since Herschel's time; but no corresponding variation in the angle $30^{\circ} 18'$ (named above) has been introduced into our works on astronomy.

The diameter of Mars is differently estimated by different astronomers. In Mädler's "Elements," 4,070 miles is assigned as the planet's equatorial diameter. Most observers assign a larger diameter: Hind, in his "Astronomy," giving the planet a diameter of 4,500 miles. These estimates are, of course, founded on the old estimate of the sun's distance. It seems probable that 4,150 miles on that estimate, or 4,000 miles, if the modern reduced estimate of the sun's distance is accepted, is not very far from the true diameter of the planet. In other words, the linear dimensions of Mars are about one-half those of the earth, or twice those of the moon; more roughly, his surface is about one-fourth that of the earth, or four times that of the moon; and, yet more roughly, his volume about one-eighth that of the earth, or eight times that of the moon.

Herschel determined the compression of Mars at $\frac{1}{16}$; modern observers greatly reduce this quantity. Professor Kaiser, of Leyden, makes the compression $\frac{1}{114}$; Main, of the Radcliffe Observatory, deduced $\frac{1}{9}$ in 1862, but in some earlier measurements made the polar greater than the equatorial diameter. Mr. Dawes, applying two modes of measurement, found, from the first, no compression; from the second, he found the polar greater than the equatorial diameter. Is it going too far to say that the oblateness of Mars' figure is not yet determined satisfactorily? Probably it is too small for measurement.

Herschel made Mars' rotation-period 24 h. 39 m. 35 s.; Mädler gives 24 h. 37 m. 23·7 s.; and Professor Kaiser considers 24 h. 37 m. 22·3 s. the true value.

Let us now turn to the opposition of January 10, 1867. Referring to fig. 1, we see that the opposition takes place when Mars is not very far from aphelion. The earth, also, being very near perihelion, is drawn as far away from Mars' orbit as *this* cause permits her to be. Mars is nearly at his greatest distance from the plane of the ecliptic. Thus the distance of Mars from the earth is very much greater than at the oppositions of 1864, 1862, and 1860. In fact, the absolute distance of Mars will be no less than 58,500,000 miles, much nearer to his

greatest than to his least limit of distance. Thus, whereas the greatest diameter Mars can present is no less than 24", and his least only 13.3", his apparent diameter on January 10 will be only 14.0". There is an error, by the way, in the *Nautical Almanac* on this point; and not a *single* error, due to an accident or misprint, but an error running through the whole series of apparent magnitudes for several months. In fact, a larger diameter is attributed to the planet than at the opposition of 1864, an error which a moment's inspection of fig. 1 is sufficient to correct.*

Next let us consider what is the polar presentation of Mars at the approaching opposition. Referring to fig. 1, we see that, since Mars was at the vernal equinox of his northern hemisphere when at M_1 , about $2\frac{1}{2}$ months ago, he will be somewhat more than one-third of the way towards the northern summer solstice at the time of opposition. Thus the northern pole will be turned towards the sun, and therefore towards the earth; but somewhat less towards the earth than towards the sun on account of the elevation of Mars above the ecliptic. Again, when at M_1 , Mars, viewed from the sun, would have appeared with his axis apparently inclined nearly 30° to the direction of his motion; at the time of observation this angle will have considerably diminished. The actual presentation of Mars will be very nearly that exhibited in the eight pictures of our illustrative plate.† In these figures, details observed by Dawes in 1864, by Lockyer and Phillips in 1862, and by Delarue in 1858, have been introduced so as to accord with the actual presentation of 1867. I have not found it an easy matter satisfactorily to reconcile these designs; neither, indeed, is it to be assumed that Mars presents at all seasons identical features. It is found, in fact, that, besides periodic changes in the dimensions of those two white caps near the polar regions which have so long been recognised as

The snowy poles of moonless Mars,

the details of other portions of his surface vary from time to time. Spots and patches clearly made out on one occasion appear blurred and indistinct on another—though the same

* I should have felt in doubt as to the correctness of my own calculations, but for (i.) the extreme simplicity of the question, and (ii.) the circumstance that the results given in the *Nautical Almanac* are self-contradictory; the horizontal parallax (always proportional to the apparent magnitude) and the distance of the planet being correctly given—the first less, the second greater, than the corresponding elements in 1864.

† In these figures the horizontal line through the centre indicates the direction of the planet's motion. His apparent motion across the field of the telescope will take place in a direction inclined a few degrees to this horizontal line, crossing it from below upwards, and from right to left.

telescope may be used, and our own atmosphere (as tested by the performance of the telescope on double stars) may be in a state as favourably fitted for definition. The colour of the planet is also variable; the redness (compared to a faint tinge of Indian red by some observers, and to a coppery tint by others), and the greenish-grey tint of the darker parts of the disc, being much more marked on some occasions than on others. Another phenomenon—the paleness of the disc round the edges—is also variable.

The variations in the appearance of Mars are clearly explicable on the natural hypothesis of an atmospheric envelope, such as that surrounding our own earth, bearing clouds and mists over the surface of the planet. Judging by the analogy of our own earth, we may consider that the planet's cloud-covering would vary in density not only from place to place upon the surface, but, considered as a whole, from season to season, and from year to year. It gives a high idea of the difficulty of the problem attacked by astronomers, in examining Mars, to note that, for favourable research, we must have a fine night upon our earth, and a clear day on Mars, combined with favourable circumstances of distance, altitude, and presentation; that we cannot watch the planet through any single Martian year, but must be content to piece in the observations of different seasons of different years; and, finally, that Mars, when in opposition at the solstice of one of his hemispheres, is nearly twice as far from us as when in opposition at the corresponding solstice of the other hemisphere.

Since, in January 1867, the north Martialis are enjoying early summer, while the southerners are entering on their long winter, the observer on earth may expect to find the northern snow-cap smaller than the southern; though the extent of the latter will not, in all probability, approach the dimensions observed by Delarue in 1858, when the southern hemisphere had lately passed through the full severity of the Martial winter. The plate represents the appearances to be looked for when an inverting telescope is used, so that the north pole is below; it is only necessary to invert the plate to obtain what we are in the habit of considering the natural presentation of such a globe.

A little consideration of fig. 1 will show that, though Mars will gradually present more and more of his northern polar regions towards the sun as he moves on to the positions M_m , and M_2 , yet to observers on earth the north polar presentation will not change in the same way. In fact, *while Mars is retrograding* (or until the middle of February; see map), his north pole will be retiring so far as observers on earth are concerned. Afterwards Mars will gradually present more and

in 1864, when compared with the horizontal parallax, assign to Mars a diameter scarcely exceeding the earth's radius; others give a diameter $\frac{1}{2}$ greater; others, in 1865, give a diameter less than the earth's radius; some, in 1866, give a diameter equal to this dimension; others a diameter exceeding it by $\frac{1}{20}$, others by $\frac{1}{10}$, others by $\frac{1}{4}$; and, finally, others by $\frac{2}{7}$, that is, by 1,150 miles.

ON WATER-FILTERS.

By EDWARD DIVERS, M.D., F.C.S.,

Lecturer on Natural Philosophy, Charing Cross Hospital.

PREVENTION is better than cure " is a maxim no less true of foul water than it is of disease. But we cannot always act upon it in the one case any more than in the other. Riches certainly may do much in preserving health, but then there are the many circumstances affecting it which are beyond human control and the force of riches. To a much greater extent, however, can money ensure the obtaining and preservation of pure drinking-water. Nevertheless, besides the comparatively narrow cases of the voyager and the explorer, there is one case which directly concerns millions where money practically fails to procure a pure supply of water; and that is the case, which applies to the dweller in London and so many other large towns, of living in a rich community the corporate authorities of which fail to see money's worth in an expenditure to procure wholesome drinking-water for their people. It is surely a terrible consideration, that thousands may be slaughtered in a few weeks by a water company through the shortsightedness and parsimony of those who have accepted the high office of guardians of the public health and wellbeing. That thousands have thus been recently destroyed in the east end of the metropolis is a matter hardly to be doubted by the unprejudiced thinker. Public feeling will no doubt *before long* obtain for London water fit to drink, as it has done for a few other large towns. But, then, "*before long*" cannot mean less than some years even in the mouths of the most sanguine sanitary reformers, and before that it is more than possible that impure water may bring upon the population a decimating epidemic. Hence the importance of the object of this article, suggested some time since to me by the editor of the *Popular Science Review*. This object is in effect to assist the reader in deciding how far means are within his reach of getting from a foul supply pure drinking-water for himself and those whose welfare is his more immediate concern.

By pure drinking-water, it may be perhaps necessary to state, is not implied water actually pure. Really pure water is only

to be obtained with great difficulty, and so far it is fortunate that it is not to be held as at all requisite for maintaining health. All that is wanted, and this is what we mean by a "pure drinking-water," is water free from everything of ascertained or suspected power to induce ill-health, and—we add this as a corollary only—from everything unpleasant to the senses and the imagination. Consequently, guided by general experience and medical authority, the presence in small quantity of chlorides of sodium, of calcium, or of magnesium, carbonate of calcium (chalk) or of magnesium, or sulphate of calcium or of magnesium, either alone or together, does not deprive a water of this title. The presence, too, of certain gases—carbonic acid, oxygen and nitrogen—leaves the water still pure for drinking purposes.

Certain other substances, harmless even for some time to those drinking water containing them in small quantity, and even health-restoring to others, render a water notwithstanding unfit to rank as a pure drinking-water. Take the example of hepatic waters (waters containing sulphuretted hydrogen) and that of chalybeate waters (waters containing combinations of iron): however useful these waters may prove to a valetudinarian, or harmless to any one for a time, they are found to be hurtful on protracted use. Other substances, again, which seem to have in themselves nothing baneful, hardly justify a drinking-water in which they are found being denominated pure. The reason of this will be sufficiently intelligible. If small quantities of nitrates are found in the water, it is in ordinary cases certain that the water has passed through matters of animal origin, and therefore is open to the likelihood of containing, in some succeeding supply, other matters derived from this source highly injurious to health. This, again, is the case with ammonia, and for the same reason; but the danger indicated by this substance is even more imminent, as water containing ammonia is almost certain to contain also noxious matters of animal origin. All matters immediately derived from animal life are objectionable in drinking-water, because of our uncertainty as to their exact nature, and therefore as to their effects, not to mention the offensiveness of their origin to our ideas. And more than this, matters derived from life at all, even though this be only vegetable, are to some extent objectionable—firstly, because we cannot acquit them of all power to do harm; but secondly, and chiefly, because we can hardly obtain sufficient guarantee in their presence of the absence of animal matters also.

For though animal matters may be practically looked upon as present if with carbonaceous (or organic) matters ammonia or nitrates be found also, or if the carbonaceous matter be found to be also nitrogenous, there may still be sufficient animal

matter in water to do harm, and yet these evidences not be attainable, or, at any rate, not to an extent that can be relied upon.

However, the presence of a very little organic matter in a water the history of which shows its impurification with sewage to be improbable, does not make it impure for drinking purposes. For not only is it difficult, if not impossible, to obtain water altogether free from organic matter, but experience shows that water whose antecedents can pass unchallenged, such as the water of the lakes, may contain a small quantity without harm.

One character of organic matter by which its power for evil may be judged of, is its liability to spontaneous decomposition—in its liability to putrefy and decay. The process of putrefying is indirectly a manifestation of the extent of the power stored up in these matters when they were part of a living organism, and, what is of greater import to us at present, an evidence of the power they have to do something—it may be good, but more likely evil—to our bodies. The test of the extent to which the bodies in water can putrefy or otherwise exhibit active powers is their capacity of combining with *oxygen*. Matters which have already combined with oxygen as far as possible, and matters which show little readiness to combine with it at all (at least those likely to occur in water), are both non-putrescible and inactive apparently when swallowed. Hence the *oxidisability* of a drinking-water becomes an important indication of the likelihood of the organic matter proving injurious. The degree of oxidisability of a water is estimated by means of the action upon it of *permanganate of potash*, a substance readily yielding oxygen. But the absence of any readily oxidisable matter in a water is shown in another way, which it is of interest to consider here.

We have already mentioned that a pure drinking-water may contain oxygen and nitrogen besides other gases. These gases in water are derived from the atmosphere, and it is found that, in consequence of the superior solubility of oxygen in water, twice as much is dissolved of it as of nitrogen although nitrogen is four times more plentiful in the air. Now, if readily oxidisable substances are in the water, they become oxidised at the expense of this oxygen dissolved, and the result is that such water contains less oxygen (if any) than twice as much as the nitrogen in it. If the water contains less than a third of oxygen of what it does of nitrogen, it may be set down as imperfectly aërated, at least so says Dr. W. Allen Miller, and as therefore containing readily oxidisable matters, that is, matters mostly dangerous to health.

Of all the qualities which a water must be free from in order that it can be looked upon as a pure drinking-water, there is one

most essential, which, not unadvisedly we think, we have refrained from noticing till now. This quality is muddiness, opalescence, or any want of perfect clearness. Of course the matters suspended may be harmless, but even so their presence still remains offensive to the eye. Usually, however, such waters contain organic matter, and in most cases the solid particles themselves which give opalescence to the water are of this kind and still in possession of vitality, either as fragments of living organisms, or as perfect, organised beings themselves. Such living particles are too probably full of power for mischief to make their ingestion in any case safe. They may be capable of development into human parasites; or they may give rise, it is believed, to specific diseases (such as cholera, supposing them to be derived from the intestines of cholera patients through the admission of sewage into rivers used, like the Thames, to supply water for domestic use); or, during the putrefaction they have to undergo after their vitality has passed away, they may very likely give rise to fever and to functional disorders of the nervous and alimentary systems.

Having thus entered at some length into what water is and what water is not to be regarded as a pure drinking-water, we shall now take under consideration the nature and effects of the different forms of domestic filters provided for domestic use. The proprietors and patentees of the various kinds of filters have, with the exception of Mr. Lipscombe, of Regent Street, sent in, on request, samples of the filters they offer to the public, in order that they may be reported upon.

The primary and essential effect of a filter should be to rid the water passed through it of all suspended matters. But in modern filters another effect is endeavoured to be produced, in order to meet the requirement that water containing objectionable matters *in solution* should be freed from them.

Many persons, when they see a water quite clear, seem to imagine that it must be in a good state for drinking. They should remember, however, that substances which entirely dissolve in water do not diminish its clearness. Hence a clear bright water may, despite its brightness, be charged with a poison or substances more or less injurious to health, such as soluble animal matters.

One of the most perfect filters is formed of carefully prepared unsized paper; but this is evidently unfitted for general use, and is only employed in chemical operations.

Beds of material in coarse powder, pervious to water, and unacted upon by it, such as silicious sand, form the means usually resorted to. In other cases porous plates and blocks are employed, such as we have presently to notice.

By forming the bed of sufficient thickness, and using

material in powder of sufficient fineness, a high degree of perfection of mechanical filtration can be reached. The limitation, of course, to the fineness of the powder and the thickness of the bed is the requirement of a sufficiently rapid filtration.

Filtration through sand, however, at the best has little, if any, effect upon the matters dissolved in water beyond that due to the agitation of the water with air by letting it fall in drops from the filtering-bed to the receiving vessel. For this reason, charcoal in coarse powder has been long used in order to remove certain matters dissolved in water. Charcoal obtained from animal matters alone appears to possess the power of removing matters from solution in water to any extent. Wood-charcoal has been, however, very much used, but with the result, consequently, of only aiding in mechanically filtering the water.

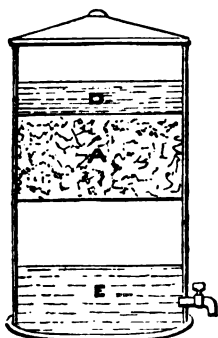
There are four kinds of filters we shall now proceed to describe as essentially different from the old sand, or sand-and-charcoal filter.

The patent moulded carbon filter consists essentially of a block of amalgamated particles of charcoal. This block is stated to be formed of animal, vegetable, and mineral charcoal, all in fine powder, and incorporated together by means of pitch. The mass, after being submitted to enormous pressure in moulds, is heated so as to carbonise the pitch. The result is a dense porous block. A glass tube is fixed in a hole in the block by means of a cork, and passes to its centre. This glass tube then passes, by means of another cork, through the bottom of the chamber containing the carbon block immersed in the unfiltered water. By this means all the water passing out of this chamber through the glass tube must pass through the thickness of the block from its exterior to its centre. Such, at least, is the assertion of the proprietors of this filter. This, however, is more than open to question; it is tolerably certain that some water *must* get through holes in the corks, and between the block and tube and the tube itself. This filter is stated to purify water from organic and other matters in solution. We are not able to endorse this statement as regards organic matters in solution but to a very limited extent. We have found that water, as supplied by one of the Thames water companies, loses very little of its colour or smell, and a chemical examination has confirmed these observations. As a mechanical filter it appears to be very good. The editor of the *Popular Science Review* informs me that he has found a moulded carbon filter quite effectual in depriving a natural chalybeate water of all ferruginous taste. A sketch of the arrangement of a moulded carbon filter is shown in fig. 2, which represents the glass sideboard filter. A cistern filter is also constructed with a moulded carbon block, which, but only to a

limited extent, possesses some of the advantages of the arrangement of Mr. Danchell, next to be described

The cistern filter sold by the London Water Purifying Company is constructed according to Danchell's patent. The chamber containing the filtering material is immersed in the water-cistern, and in whatever way the tube passing out of the

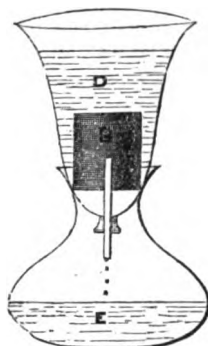
Fig. 1.



SILICATED CARBON FILTER AND MAGNETIC CARBIDE FILTER.

- A, Silicated Carbon or Magnetic Carbide.
D, Unfiltered Water.
E, Filtered Water.

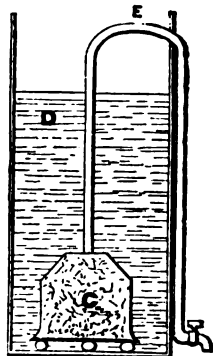
Fig. 2.



MOULDED CARBON FILTER.

- B, Moulded Carbon.
D, Unfiltered Water.
E, Filtered Water.

Fig. 3.



LONDON WATER PURIFYING COMPANY'S FILTER.

- C, Animal Charcoal.
D, Unfiltered Water.
E, Siphon.

cistern is made to go, the water during filtration passes *upwards* through the filtering material. Fig. 3 represents a section of this filter with the delivery tube arranged as a common siphon, passing out of the top of the cistern.

By this method of filtration, only those particles which have not subsided before the water passes through the filter come in contact with the filtering material, and even then in such a position as to favour their falling away from it to the bottom of the cistern. In the ordinary arrangement of filters all the matters suspended in the water, whether separated by subsidence or filtration, lodge in and on the upper parts of the filtering material, thereby more rapidly choking up its interstices. The pipe delivering the filtered water is closed by a tap, and the water is only drawn off through the filter as wanted. This arrangement is attended with both advantages and evils. The great advantage we see in it is that the water, in quantity sufficient to charge the chamber containing the filtering material, *remains in contact* with this material during the period—it may be for many hours—between the times of drawing off any water: in consequence of this, whatever purifying power is

possessed by the material is exerted for this period upon the water, instead of during the very short time that water takes in passing through a filtering medium. On the other hand, this filter being constructed to yield a flow of from half to several gallons per minute, there is the disadvantage attending such rapid filtration that the water is subjected to the purifying action of the material for such an exceedingly short period. However, admitting the correctness of these remarks, it is obvious that, by only drawing off small quantities at a time—say not more than a pint or two from the smallest size—the advantage of the arrangement remains in full.

An advantage spoken of by the company, the importance of which will be generally undisputed, is not, however, felt by ourselves to be very material: for if the water is properly purified, storage in a close vessel of earthenware or glass, as is practised in other filters, will not diminish its freshness or its wholesomeness. An objection, in our opinion, to the cistern arrangement, also lies in the very rapid passage through the filter which is required to maintain the comparatively large stream issuing from the tap, since, in order to allow of this, the mechanical filtration is very liable to be imperfect.

The only material employed by the London Water Purifying Company is, we believe, animal charcoal. The high purifying effects, therefore, of their filters is not to be wondered at, though not the less, therefore, of the most material value.

Of the filtering capacity, in the mechanical and proper meaning of the term, of Danchell's filter, we cannot speak very positively; and we do not, therefore, challenge any statement as to its excellence or otherwise. Its purifying effects are exceedingly striking. All the objectionable sensible qualities of water due to organic matter are removed from the water, and chemical examination shows that nearly the whole of the organic matter is removed; together with this nearly all the dissolved gases and the dissolved chalk. The latter effects show the powers of the filter, and render the water better fitted for culinary and domestic properties; but they are hardly desirable when the water is for drinking, as it becomes somewhat insipid, through the loss of its chalk and dissolved gases.

Of the two filters we have yet to notice, we have found the one we are going next to describe to lie intermediate in power of purifying water from dissolved organic matters. Its filtering powers seem to be excellent, and we are inclined to think that it admits of being more surely constructed, so as to filter effectually in every case, than other filters. Our reason for so thinking is, that being formed of a slab of the filtering material cemented into a vessel, so as to divide it into two chambers, it seems only necessary to select slabs free from flaws to make it

certain that all the water passes through the pores of the material. Fig. 1 serves to give some idea of this arrangement, only that the filtering-slab appears there as much too thick. The slab is prepared from the coke of the Torbane Hill mineral or coal, and is represented by the proprietors of the patent (Dahlke's) to owe its activity to the silica as well as the carbon it contains.

Thames water, as supplied by the water companies, passes through these filters with the loss of most of the colour due to organic matters, and quite free from sensible particles of matter in suspension. Its discoloration is not so completely effected as it is by the animal-charcoal siphon-filter last described. A chemical examination indicates a partial removal only of organic matter, but then this is of the more offensive and least oxidised portion.

The last filter we shall give some account of is the magnetic carbide purifying filter, patented by Mr. Thomas Spencer. This filter, represented by fig. 1, is formed of a layer of "magnetic carbide," contained between two perforated stone-ware partitions. A thin layer of sand is usually placed next the lower partition, to increase the mechanical filtering effects of the filter; and, when the water to be filtered is unusually turbid, a sponge is placed above the filtering material, through which all the water is first strained, so that the larger quantity of the suspended matters may be removed, and so kept from choking the pores of the layer of filtering material. This material, called by Mr. Spencer "magnetic carbide," consists essentially of black or magnetic oxide of iron, but having also some carbon combined with it, according to the patentee. It is prepared by heating hæmatite or red oxide of iron with saw-dust in close vessels. The product is magnetic. Mr. Spencer claims for this material the property of never losing its activity so long as its pores do not become choked up. The same cannot be said of animal charcoal, which, after a time, loses much of its purifying power. We have been able to judge of the effects of a domestic filter that had been years in use, and its action seemed to be undiminished. As the action of the magnetic carbide stands comparison with that of fresh animal charcoal, its permanence of action places it before all other filtering materials. Spencer's filters appear to be little, if at all, inferior to the animal-charcoal filters freshly mounted. Water passed through them loses all but a very small quantity of its organic matters. As mechanical filters they seem to be also excellent.

The magnetic carbide was employed in making the filtering-beds of the water company at Southport, and after years of use is still, we understand, giving every satisfaction. From its mineral character it is suited for this purpose, whereas charcoal

would be found too friable, not to mention that after a short time it would have to be renewed. One slight objection to the action of the magnetic carbide upon water is that it is apt to render it *very* slightly contaminated with iron if the water contains much carbonic acid.

It will thus be seen that, in the magnetic carbide filter of Spencer, the cistern-filter of Danchell, and the silicated carbon filter, we may possess with tolerable certainty the means of freeing water from matters injurious to health. The uncertainty lies in the fact that the particular filter used by a person may be imperfect as a mechanical filterer, and may have become inefficient as a purifier from dissolved organic matters, unless, as regards the latter point, it be a Spencer's filter, and have only been used with water of tolerable clearness (such as that supplied to London), and not largely charged with carbonate of lime in solution. Hence arises the propriety of having a filter examined after being placed in a house, in order to test its efficiency. This ought to be done by the filter-sellers.

OUR FRESHWATER ENTOMOSTRACA, SHELL- INSECTS, OR WATER-FLEAS.

By W. BAIRD, M.D. F.L.S.

OUR freshwater lakes, ponds, and ditches swarm with an infinity of living creatures, and even our slow-running sluggish streams and rivers afford a safe habitation for numberless minute species of the animal creation. Conspicuous amongst these denizens of the fresh water are the little Crustaceans known to zoologists by the name of Entomostraca.

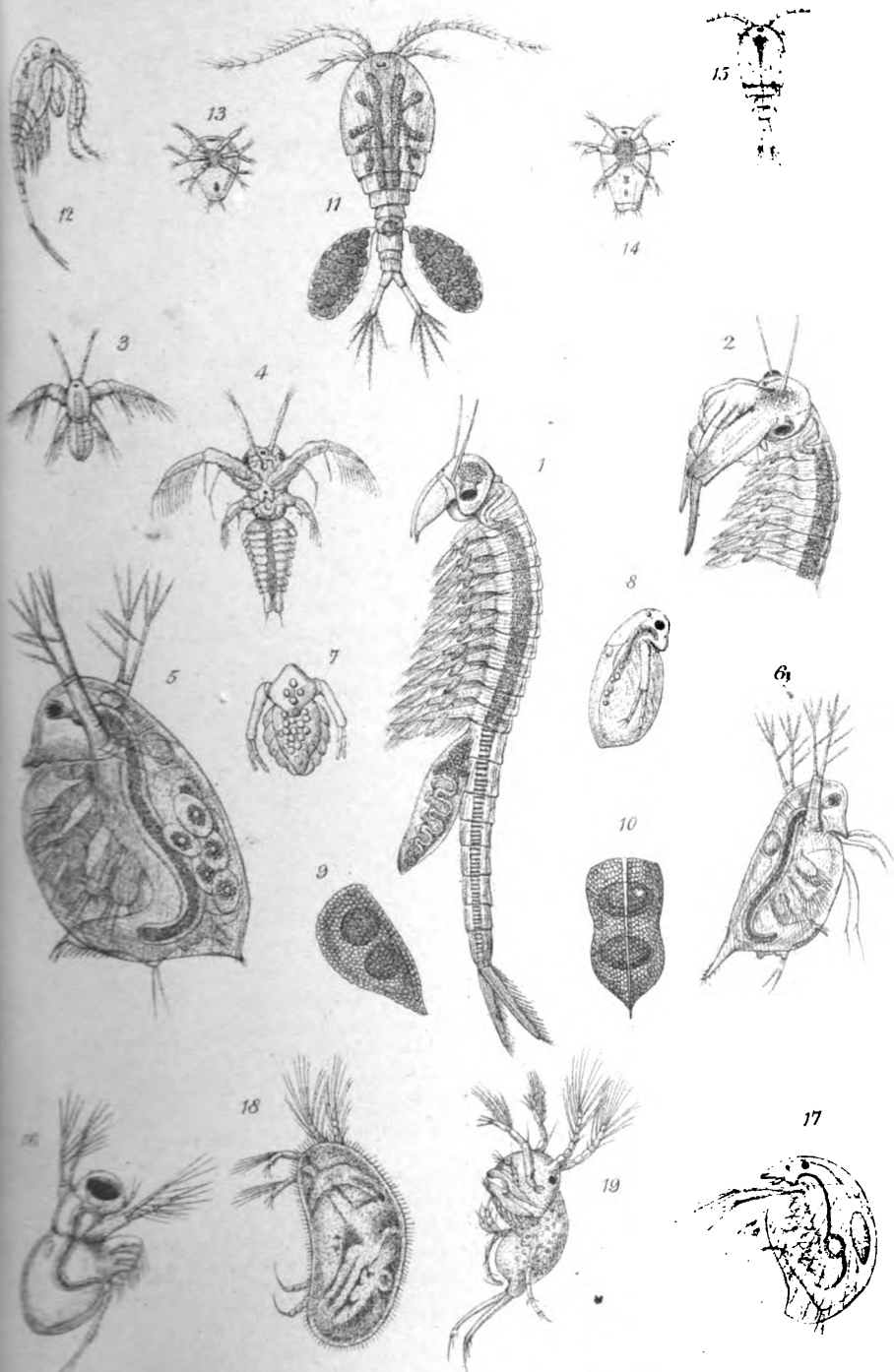
Distinguished, as a great majority of them are, by possessing, or appearing to possess, a single large eye, the species which were known to Linnæus were almost all included by that celebrated naturalist under the simple term *Monoculus*.* The most eminent, however, of all the succeeding earlier historians of these little creatures, the celebrated Danish zoologist, Otho Fridericus Müller, looking at them from another point of view, conferred upon them a different name. The singular appearance which most of them present, viz. annulose animals or *insects* covered with what appears at first sight to be a bivalve shell, supplied to him the appellation of Entomostraca,† or *shell-insects*, a name by which they are still known, and which has been retained by almost all succeeding authors.

A great many of these *shell-insects* are natives also of the waters of our seas and estuaries, and play a by no means despicable part in the economy of creation. At present, however, we limit ourselves to the inhabitants of our fresh waters; and, indeed, the interest attached to their history is great. Müller's description of them is in elegant Latin, and his work ‡ is still one of the most interesting memoirs in natural history. Jurine, in his work on the Freshwater Monoculi of the neighbourhood of Geneva, tells us that he had studied these little creatures for many years, and that each succeeding year only added to the interest he felt in them.

* *Monos* (Greek), one; *oculus* (Latin), eye.

† *Entomos* (G.), an insect, *ostrakon* (G.), a shell.

‡ Entomostraca, seu insecta testacea, quæ in aquis Daniæ et Norvegiæ reperit, descripsit et iconibus illustravit Otho Fridericus Müller. *Lipsiæ et Havniæ*, 1785.



These minute shell-insects, then, or Entomostraca, belong to the great class *Crustacea*, and, though possessing extreme delicacy of structure, are formed on the same model as our shrimps, prawns, and lobsters. They have a brain, or several nervous knots, called *ganglia*, which supply its place; a heart, which is generally placed near the centre of the body, and propels the blood or circulating fluid to the different organs; and gills, or *branchiæ*, attached either to the feet or organs of mastication, by means of which respiration is carried on. They are all aquatic, and in general are covered externally by a shell, or what is called a *carapace*, formed of one or two pieces, of a flexible horny texture. They have more or less well-formed organs of mastication, and have jointed ciliated feet, well adapted for the purpose of swimming. These creatures vary much, however, in their general appearance, and have been divided by naturalists into several large groups, or orders. We append a short description of these in a note below.*

* Our freshwater shell-insects, living free and unattached in the water, are all contained in two great divisions, or legions, called—

I. BRANCHIOPODA,* Branchiopods; which are characterised by their having many gills or *branchiæ*, which are attached to the feet, these latter varying in number, in some being very numerous, and only formed for swimming; by their body being either naked or having an envelope in form of a buckler, in some enclosing only the head or thorax, in others the whole body; and by their mouth being furnished with organs fitted for mastication.

II. LOPHYROPODA,† Lophyropods; which are characterised by their having few gills or *branchiæ*, which are attached to the organs of the mouth; by having few pairs of feet, and these serving chiefly for purposes of locomotion; by their body having always an envelope, either in form of a buckler enclosing the head and thorax or in shape of a bivalve shell enclosing the whole animal; and by their mouth being furnished with organs of mastication.

The first legion, the Branchiopoda, are divided again into two orders:—

1. PHYLLOPODA,‡ Phyllopods; which are characterised by their having the body either naked or having only the head and thorax covered by the carapace; by having numerous pairs of feet, the joints or articulations of which are foliaceous or leaf-like, and perform the part of organs of respiration, instead of locomotion; and by their feelers or antennæ being small and not adapted for assisting the animal in swimming.

This order contains the *Apus* and *Chirocephalus*.

2. CLADOCERA,§ Branched-horned Water-Fleas, which are characterised by their having the whole body, with the exception of the head, which is distinct and projecting, entirely enclosed within a carapace formed of two

* *Branchia* (G.), gills; *pous* (G.), a foot.

† *Lophurus* (G.), having stiff hairs; *pous* (G.), a foot.

‡ *Phyllon* (G.), a leaf; *pous* (G.), foot.

§ *Kladon* (G.), a branch; *Keras* (G.), a horn.

The freshwater Entomostraca, as we have at the commencement observed, are to be found in great numbers in our ponds and ditches; and though they may be observed during most months, it is in summer and autumn that they are to be seen in greatest abundance.

At that season of the year, then, let us seek some quiet spot, a little way from town, and turn to "Where the pool stands mantled o'er with green," and see if we can discover any of our little friends lurking there, or playing "amid the floating verdure" which covers the surface. A small hand-net cautiously introduced, and, when removed, washed out into a small basin of clear water, will furnish us with hundreds of the objects we are in search of. First and foremost we see a creature of somewhat tolerable dimensions and oval shape, transparent almost as glass, except a rather broad dark streak running down through the centre of its body, and a large spherical black spot placed right on its forehead. It is furnished with a pair of powerful-looking branched organs projecting from its head, which may be seen waving to and fro in almost constant motion, so that the animal is seldom at rest, but is perpetually moving by short sudden bounds through the water. This is the common water-flea with branched horns, the *Daphnia pulex** (figs. 5, 6).

This water-flea is really a beautiful animal as seen through the microscope, and its history will well repay our attention for a short time.

valves, joined together on the back; by having fewer pairs of feet, chiefly branchiform, and adapted for respiration and not locomotion; and by having two pairs of feelers or antennæ, the inferior of which are large, branched, and perform the functions of swimming organs.

This order contains the various kinds of branched-horned water-fleas, the *Daphniæ* and *Lyncei*.

The second legion, the Lophyropods, are likewise divided into two orders:—

1. OSTRACODA,† Ostracods; which are characterised by the animals having the body enclosed entirely in a covering of two valves, resembling a bivalve shell; by the gills or branchiæ being attached to the hinder jaws; and by having only two or three pairs of feet, chiefly adapted for progressive motion.

This order contains the little creatures known as the *Cyprides*, &c.

2. COPEPODA,‡ Copepods; which are characterised by their having the body more distinctly annulose than those of the other orders, and covered by a buckler which encloses head and thorax; and by having five pairs of feet adapted for swimming.

This order contains the shell-insects known as the *Cyclops*, or four-horned water-fleas, and allied genera.

* Legion, *Branchiopoda*; order, *Cladocera*; family, *Daphniadæ*.

† *Ostrakon* (G.), a shell.

‡ *Kope* (G.), an oar; *pous* (G.), a foot.

The body is contained within a delicate shell composed of two valves, soldered together, as it were, on the back, and open on the anterior margin, through which the feet and tail can be protruded at pleasure. Posteriorly these valves are prolonged to an acute point. The head is bold, and projecting from the rest of the body, and the black spot on its forehead is the eye. This organ is furnished with powerful muscles, so arranged as to allow it to possess a semi-rotatory motion upon its axis, and is compassed about with numerous glassy-looking or crystalline lenses. The two large branched organs projecting from the head are called the large antennæ; and it is by means of these organs that the water-flea is able to propel itself through the water. The mouth is situated near the base of the beak, and is furnished with two mandibles and one pair of jaws. The broad dark streak running down through the body is the stomach, which we see curved at its upper part into a complete arch, and then running nearly straight downwards through the body till near its extremity, when it curves suddenly again in an upward direction. This part of the animal and the remaining portions of the body can be seen quite clearly and distinctly through the carapace or shell. The body proper terminates in a broadish plate, which ends in two horny-looking hooks; and this part forms what is called the tail, and, with the greater part of the body, can be extruded beyond the valves at pleasure. The legs are five pairs in number, and even when the little creature is at rest, these organs may be observed to be in constant motion, which communicates an undulatory motion to the water, establishing a regular current which carries the particles destined for its food towards the mouth. The chief use, however, of these organs is for respiration, and for this purpose they are well adapted by their having a branchial plate attached to them, furnished with long plumose setæ or bristles, and which answers the same purpose as the gills of the crabs and lobsters, &c.

In the females (fig. 5), the ovaries are internal, are placed along the sides of the stomach, and show their situation by the eggs appearing there in the shape of small round pellucid globules.

In this pool in which we have found these daphniæ, they are all clear and transparent; but at times, and in other situations, they become of a red colour, and, when very numerous, as they sometimes are, they impart, at first glance, a red hue like blood to the whole pond in which they are observed. When this was first noticed, it was looked upon as a bad omen, and some calamity was prophesied as sure to follow. I have often seen this phenomenon in horse-ponds and such like places, and have often been surprised to see suddenly large patches of the pond become of a ruddy hue, like as if a quantity of the red rust of

iron had been mixed with the water, or as if a current of blood had flowed into it.

There are two or three facts connected with the history of these water-fleas which are marvellous to our comprehension; and as these animals are easily preserved alive, it is no very difficult matter to watch the various processes and witness the extraordinary facts with our own eyes.

The first thing which strikes the investigator into their history is the wonderfully prolific nature of the little creatures. They give birth to young a great many times during the short season of their lives, and some of the larger species have as many as forty or fifty eggs and upwards in their ovary at once. About ten days after birth, the young ones begin to have eggs! and it is probable they continue to produce fresh broods all the summer through at frequent intervals. The males (fig. 6) are very few in number compared with the females, and it appears a well-established fact that, when a female once becomes impregnated, her fecundity continues for life without any further intervention of the male, and this fecundity is transmitted to her female descendants for many successive generations. I have, by isolating them immediately after birth, proved the fact that the young daphnia, born during the early summer, does not require the access of the male to become a mother, and have, by repeatedly isolating the young as soon as they were born, succeeded in following up the successive generations as far as the fourth, and Jurine has followed them up as far as the sixth without any diminution of their fertility. At particular seasons of the year the mature daphniæ may be observed to have a dark opaque substance on the back of the shell. Müller, who first noticed this appearance, for want of a better name, called it the *ephippium*, or saddle, but Strauss has shown that in this peculiar-looking substance there are gradually formed two eggs, which have been called the *winter eggs*, and which, at a certain period of the animal's life, are thrown off its back and left to float on the surface of the water (figs. 9, 10). In this *saddle* the eggs remain during the winter, protected from the severity of the cold, till the spring comes round, when they are hatched by the returning warmth of the season. These young daphniæ are exactly similar in appearance to those produced direct from the mother, and, strange to say, are equally independent of any access of a male for fecundation. By isolating the young from these *winter eggs*, I have followed up at least four successive generations, without seeing any diminution of their prolific nature.

Another very curious fact connected with the history of these animals is the regular process which they undergo of *moulting*, or casting their old shell and forming a new one. Though this

process is not peculiar to these water-fleas, but is common to most of the Crustacea, it is yet so easily observed that it becomes extremely interesting to watch it. It is one which in early life is all-important to the existence of the creature, as by the time it casts its shell the body has increased in size, and thus it requires a new and larger habitation. Even in the mature state, it seems to be necessary for the animal's wellbeing. Living for the most part in water which abounds in the parasitic freshwater Polyzoa, Confervæ, &c. the shell of the daphnia soon becomes overgrown with these organisms, which intrude themselves even into the interior of their carapace, thus materially impeding the poor creature's motions and ultimately destroying its life.

The changes which the young undergo in their progress to maturity are equally interesting to the observer of their habits and manners. The mother is ovo-viviparous; the eggs, as soon as they leave the ovary, take their place in an open space on the back, where they remain quite free and unattached till the time of expulsion. In general, about the end of the fifth day, these eggs are hatched, are tolerably well developed, and are then launched into open day. These young differ but little in form from their parents, except in the smaller development of their parts (figs. 7, 8). When first expelled, the young have a long spine at the extremity of their shell; this, however, at first is curled up within the shell, and it is not till they have been in the water for a few seconds, and begun to move about, that this tail suddenly, and with a jerk, springs out and assumes its natural position. The hairs of the large-branched antennæ may be seen to spring forth in the same sudden manner, being previously folded up along the stem. In a short period after its birth, the young animal is exactly like its parent, gradually increasing its size, and casting its shell as it grows, till it assumes the perfect state of the mature daphnia.

The species of water-fleas belonging to the *Daphniadæ*, hitherto described as British, are about fourteen or fifteen in number, and may be met with in similar situations as the *Daphnia pulex*.

In the same haul of the net as this in which we have found the branched-horned water-flea, we find another entomostracon perfectly different in shape and appearance from the last, and possessed of four large horns or antennæ. This is the Four-horned, or smaller, Water-flea, the *Cyclops quadricornis* * (figs. 11, 12).

The history of this little creature is equally interesting as the preceding. The body of the animal is enclosed within a horny

* Legion, *Lophypoda*; order, *Copepoda*; family, *Cyclopidae*.

shell, which covers it like a buckler, but opens inferiorly, to give issue to the antennæ, organs of the mouth and feet.

In this water-flea, as in the other, a distinguishing mark is the single large eye on the forehead, which in some of the species is of a fine ruby colour. The large antennæ, or horns, as they were wont to be called by the earlier writers, are four in number, the two upper of which are long and generally composed of numerous joints or articulations, furnished with short hairs or setæ. Immediately below the antennæ is situate the mouth, and a little lower down we see a pair of organs called by some the *foot-jaws*, and by others the *hands*. Descending in the body, we next see the feet, which are five pairs in number, and are each double, or composed of two stalks arising from a common base, each stalk consisting generally of from two to four joints, more or less furnished with hairs. These feet, in this species of entomostræon, are solely adapted for the act of swimming, instead of serving, as in the preceding, for respiration. In the female (fig. 11), the young are not hatched in the internal ovary, as in the daphnia, but the ova are very soon passed into an external ovary, which forms a little bag, projecting on each side of the tail, and remain suspended there for several days. In this external ovarian bag the ova remain till they are hatched, when the sac bursts open, and the fry are ushered forth into life. But how unlike the parent do these young ones appear! The earlier observers of these newly-born animals could scarcely believe their own eyes. The celebrated microscopist Leeuwenhoek, amongst the first to notice this fact, was so surprised at the unexpected discovery that it was not till after repeated experiments that he became satisfied with the result, and was persuaded that these little creatures, so different in appearance from the parent, were actually born from the very eggs which he had been so patiently watching.

Immediately after birth, the young animal presents the appearance represented in fig. 13, a form so very different from that of the adult that Müller actually could not believe his predecessors who had witnessed the birth, but placed it in a distinct genus! It is extremely curious and interesting to watch the transforming process which these little creatures undergo. It takes about twenty days from the birth, more or less, according to the heat of the weather, before they have become perfect animals. The body gradually becomes elongated; segmentation takes place (fig. 14); the feet by degrees take on their proper form, till at length the little creature throws off its shell, or moults, and assumes, though not completely developed, the shape and appearance of the adult (fig. 15). After the third moulting, it is perfect and capable of reproducing its species. The process of moulting is equally curious and interesting in the four-horned

water-fleas as in the daphniæ. The new shell or covering having grown under the old one, when the process of changing it commences, the insect fastens itself to the bottom or side of the vessel in which it is, or to any solid object near it, so as to give itself support; then, by moving its limbs and shaking the valves of the shell, it loosens the old covering, and in a short time frees itself from it altogether.

The fertility of these water-fleas is enormous; specimens of the *Cyclops quadricornis* are often found carrying thirty or forty eggs on each side. One female has been seen to lay ten times successively, and one access of the male suffices to fecundate the female for life. Jurine has watched the hatching of the eggs and the increase of this little creature with great care, and has given us a calculation by which we may easily ascertain the amazing fertility of the species. He supposes, to be within bounds, that the female lays eight times within three months, and each time only forty eggs. At the end of one year this female would have been the progenitor of 4,442,189,120 young! To counterbalance this amazing fertility, they have many enemies; and both young and old are devoured in vast numbers by various aquatic animals that exist in the same ponds and ditches in which they reside, as well as by the cattle that come to drink these waters.

The number of species of the family *Cyclopidae*, described as living in the fresh waters of Great Britain, are few, amounting to only five or six; the greater number being natives of salt water.

Such are the leading facts and details of the development and history of the greater portion of our freshwater Entomostraca. The two species we have selected are amongst the most common of all our shell-insects, are to be found in all our stagnant pools, ponds, and ditches, and may be easily procured and preserved by any person who would wish to cultivate a further acquaintance with the group to which they belong.

Many other and very beautiful species, however, are almost equally worthy of the reader's attention. Let us, for instance, take a stroll as far as Blackheath. On that most delightful of the "lungs of London," we find many pools and little ponds of water, some of which are dried up during the heat of summer and filled again in autumn, when heavy rain has fallen. We will select this one among the gravel-pits near the gates leading to Greenwich Park, and, throwing in our hand-net, bring it to the brink, and wash it into our little basin. An extraordinary sight is thus brought before us. Thousands of fine large-daphniæ, of two or three kinds, two or three species of lynceus and cyclops, and myriads of the little bivalve shell-insect called cypria, swim rapidly in the water. Conspicuous, however,

amongst them all, behold a creature of nobler mien and appearance moving stately along, a whale amongst the minnows! It has no shell or carapace, but is quite uncovered. It is about an inch in length, is nearly transparent, but beautifully tinged in parts with red and blue. The feet appear to be rather numerous, are all leaf-like or foliaceous, and seem to be in constant motion. The creature, unlike most aquatic animals, swims on its back; and as it gently glides along, its feet are waving to and fro with an undulatory motion, like as when the wind passes over a field of corn. This is the Fairy-Shrimp, the *Chirocephalus diaphanus* * (figs. 1, 2).

This "fairy-shrimp" is of a slender, elongate form, and is remarkable on account of the shape and structure of the head. It has two kinds of antennæ, one pair slender and thread-like, the other, the lower pair, like two horns. In the female they are comparatively small, but in the male are remarkably large, the basal joint of a beautiful transparent bluish-green colour, the extremity tipped with a fine red hue (fig. 2). Attached to this are various organs which we have not space to describe, and which give it a remarkably complicated appearance. Unlike the generality of the Entomostraca, the fairy-shrimp has *two* large eyes, one on each side of the head, standing out upon projecting foot-stalks. The feet are eleven pairs in number, and serve the purpose of gills, for respiration. The body terminates in a tail composed of two fin-like divisions, which are finely feathered on the edges, and it is by this organ that progressive motion is produced. Striking the water rapidly from right to left, it impels its body forwards, and darts away like a fish. It is certainly the most beautiful of all our native Entomostraca, and as it moves with graceful elegance through its liquid element, forms a sight which the most indifferent observer cannot see without pleasure. The female (fig. 1) has a large external bag of eggs, which, when the proper time arrives, opens at the point, and the ova are thrown out by a sudden jerk loose into the water. These eggs vary in number from 100 to 400 at each laying, and in about a fortnight they are hatched, and the young issue forth into the world. Like those of the cyclops, the young are very unlike the parent. At fig. 3, we have represented one soon after birth. This shows a little creature consisting of two nearly equal portions, head and body. In a short time we can observe it moult, or cast off its shell (fig. 4); and if we watch carefully, we may see this process repeated at short intervals, and can trace the gradual development of the larval animal till at last it appears in the state of the perfect insect.

In the neighbourhood of London, there are many localities

* Legion, *Branchiopoda*; order, *Phyllopoda*; family, *Branchipodidæ*.

for the rarer kinds of Entomostraca, which are well worthy of a visit. On the banks of the Thames, nearly opposite the village of Isleworth, not far from Richmond, there is a famous ditch which produces an immense number of both plants and animals. In one spot of no great extent, a successful haul of the net will bring to our view a multitude of Entomostraca. Amongst these we will find a very delicate transparent creature, which has been well described as "having a head all eye." This has been named by Müller the *Polyphemus* * *oculus* (fig. 16). Constructed somewhat like a daphnia, this animal appears formed of a large black head, and still larger transparent body. The feet are four pairs in number, but do not appear to be contained within the shell, projecting, as it were, outside of it. The branched horns or feelers, like those of the daphniæ, are large, and serve the animal as organs of progressive motion. The head is prominent, and appears to consist chiefly of a large black mass placed prominently on its forehead. This is its eye, is very large, is provided with a set of muscles which give it a semi-rotary motion, and is beset all round the upper and outer edges, with about twenty lucid crystalline lenses. The large lower portion of the shell serves as a matrix, or receptacle for containing the eggs. These are few, generally only about six in number. This little polyphemus appears to be a very delicate creature, and is very difficult to be kept long alive in captivity.

In this same ditch, we find, along with the polyphemus, numbers of little Entomostraca, belonging to the same large group as it and the daphniæ. These animals (the *Lynceidæ*) are contained within a fine transparent shell, have much smaller horns or antennæ than the daphniæ, have the stomach, which runs through the whole length of the animal, convoluted, that is, forming one and a half complete twist or turn round itself, and in addition to the eye, which is so prominent a figure in this group, they have a small black spot at a little distance in front of it. The species we have selected for representation is the Harp-shaped Lynceus, the *Acroperus harpæ* † (fig. 17), a remarkably pretty creature and full of energy. Owing to the comparative smallness of the branched horns or feelers, the lyncei, instead of swimming by irregular bounds, like the daphniæ, direct themselves by rapid motions of these organs straight towards the point to which they wish to go. Their habits and economy are very much the same as those of the

* *Polyphemus*, the giant celebrated in the *Æneid* of Virgil, as having only one eye in the centre of his forehead. Legion, *Branchiopoda*; order, *Cladocera*.

† Legion, *Branchiopoda*; order, *Cladocera*; family, *Lynceidæ*.

daphniæ, and they are rather numerous in species. The harp-shaped lynceus, being very clear and transparent, is well adapted for giving a good idea of the whole family.

There remains another group of freshwater Entomostraca to be mentioned. This is the family *Cyprididæ*.* The animals of this large family are remarkably similar in appearance (at first sight) to a small bivalve shell; and indeed, when dried, have often been mistaken for small molluscs.

The body is contained entirely within the carapace, which is formed of two valves, open in front, and attached to each other at the back by a sort of ligamentous hinge. They have only two or three pairs of feet, which, when the animal moves through the water, or creeps on the surface of the mud or leaves of aquatic plants, are protruded through the open front of the shell. This shell the animal can open or shut at pleasure, and being rather thick and opaque, the little creature can withdraw itself completely from view, as well as protect itself from all its minor enemies ever ready to attack it. The cyprides are to be found in every pond or ditch where the water remains stagnant, and sometimes in immense numbers. They are not so prolific as the four-horned water-fleas, already mentioned, but in some of the larger species we can count as many as twenty-four eggs in a single individual. As in the Cyclopidae and Daphniæ, a single impregnation lasts the animal for life, as well as all its successive generations. The mother deposits her eggs upon some such bodies as the leaves of aquatic plants, and frequently various individuals combine to fix on the same spot a mass of eggs, consisting of several hundreds. In about four or five days, these eggs are hatched, and the young come forth already covered with a shell, and having the appearance of the perfect animal. They seem to excel all the other Entomostraca in being able to stand the influence of drought. When the ponds and ditches in which they live become dried up in summer, they bury themselves in the mud as long as it retains any moisture, and may be found active as ever immediately the rain falls and again overflows their habitations. These little creatures appear to enjoy a very lively and active existence in their native element. Instead of being fixed to one spot, and condemned to live in comparative darkness, like the mussels and other molluscous animals which they resemble in external appearance, they can open their shelly valves at pleasure, "enjoy the light and move about at their will, sometimes burying themselves in the mud, and at others darting through the water, the humid element of their sphere. If they meet any unforeseen object, they conceal themselves at once

* Legion, *Lophyropoda*; order, *Ostracoda*.

within their shells and close the valves, so that force and address seek in vain to open them." We have selected one of the most common species to be found in the neighbourhood of London and elsewhere as our illustration, the Three-streaked Cypris (*Cypris tristriata*; figs. 18, 19). The shell itself with the animal withdrawn looks like a small bivalve shell (fig. 18), being of an oval form and somewhat kidney-shaped. It is of a green colour, and the hinder portion is marked with three narrow bands or streaks of a still deeper green. To see the enclosed animal, we must carefully break down the shell and dissect the body out. When carefully done, it appears like fig. 19.

Such are some of the inhabitants of our fresh waters. It is difficult in a short space to do justice to them, for—

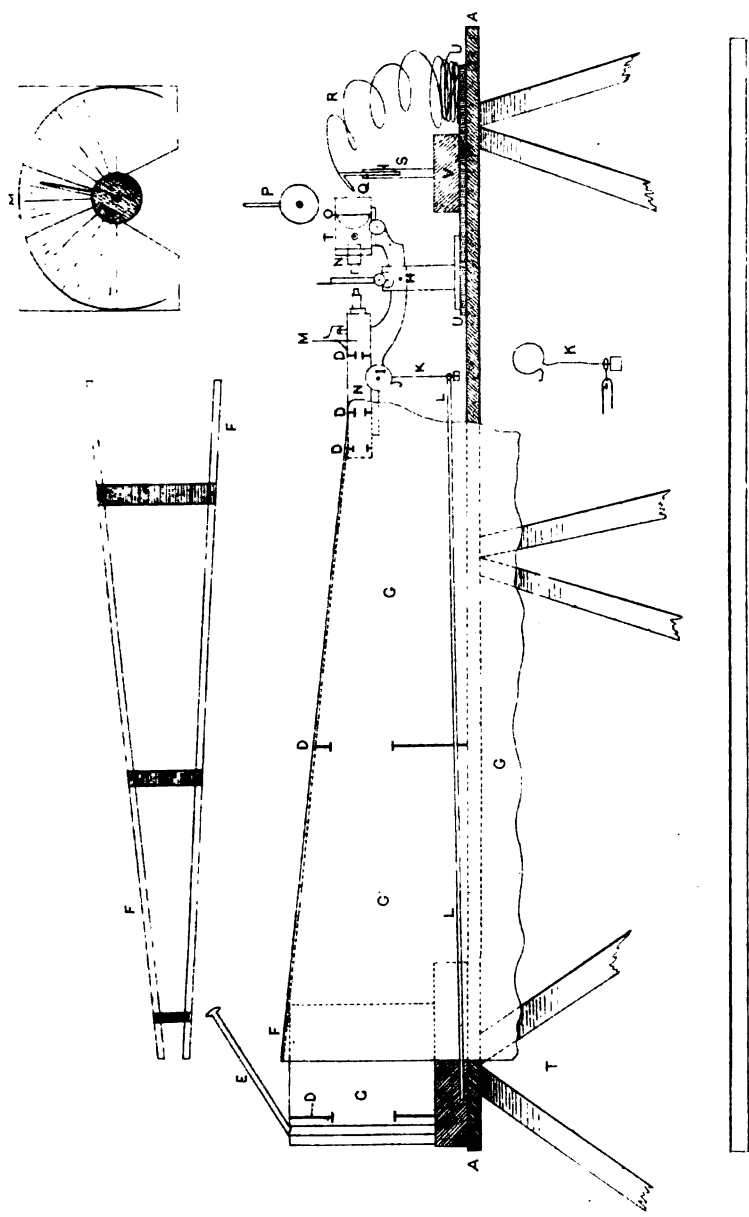
Full Nature swarms with life; one wondrous mass
Of animals, or atoms organised.

HOW TO PHOTOGRAPH MICROSCOPIC OBJECTS.

By EDWARD T. WILSON, M.B. Oxon.



“MICROPHOTOGRAPH” is a very long name, recently introduced, to denote a very small object; it refers to the minute photographic reductions of portraits or views so often shown as curiosities under the microscope. “Photomicrograph,” on the contrary, is a name given to the photographic enlargement of a microscopic object. It is now some twenty-seven years since the Rev. Mr. Reade, in the early days of photography, startled the scientific world by the magnified image of a flea, which he exhibited at a soirée given by the Marquis of Northampton; and since that time many persons have turned their attention to the delineation of microscopic objects by photography with more or less success. Instruments have been improved, and the photographic processes have been so far simplified that at the present day this new art appears likely to attain an accuracy before unknown, a certainty in results, and a wideness of application which will tend to place it amongst the most useful branches of photography: not only can sections of animal and vegetable tissues, insects entire or in part, be represented with the most minute detail, but even the finest markings of Diatomaceæ, difficult to resolve with the best light and the most skilful manipulation, are represented on paper with the utmost fidelity. Microscopists have long felt the want of some method by which their observations might be recorded at first hand, as it were, without passing through the brain of the artist, and receiving the unconscious impress of his mind during the process by which the image received on the retina is transferred to the paper before him. When it is wanted, for instance, to prove some disputed point by dissection, a good photograph would carry conviction where the most faithful drawing would still leave the question in doubt. Changes in growth and development may be fixed for ever, and the minutest differences recorded with unerring accuracy for the purposes of future study and comparison. Much, no doubt, remains to be done before these most desirable results can be fully arrived at, but difficulties



The Microscope arranged for Photography

and imperfections are gradually disappearing under the hands of Dr. Maddox, and others who have devoted much time to the subject; and it is not unreasonable to expect that, with improvement in the various printing processes, the field of microscopic illustration by photography will be largely and indefinitely increased.

In the present paper, I shall confine my remarks to the use of artificial light in photomicrography, in the conviction that it will eventually supersede the use of sunlight for these purposes, and that even now it will recommend itself by its many advantages to an increasing number of microscopic observers. Not only are the arrangements simpler and less costly with artificial light than with sunlight, but any room and any season is equally suitable; there are no gloomy days, no fog, no winter to interfere with the operations. In the uninterrupted quiet of a long winter's evening, by a comfortable fire, the student of natural phenomena has everything at his command, and is enabled to record with a faithfulness otherwise unattainable many interesting appearances which would otherwise be irretrievably lost.

But if photomicrography offers so many advantages, why, it may reasonably be asked, is it so little practised as an art? The answer will probably be found in the expenses attending the purchase of necessary instruments, and the difficulties inseparable from microscopic and photographic manipulations. I think these are exaggerated, and it will be one object of these pages to show how anyone in possession of a good microscope may at a very trifling expense provide himself with every other requisite for photomicrographic work.

The arrangement adopted by Dr. Abercrombie* and myself is rude and perhaps unsightly, but it has the merit of cheapness in construction, simplicity, and perfect efficiency. No special apparatus has been introduced which cannot be made at home by the exercise of a little ingenuity and adaptation of available resources.

Operating-Room.—Any sitting-room will fulfil all the conditions of a photographic chamber. Our own work was at one time carried on in a drawing-room. A candle shaded by a tripod stand of yellow calico, a steady table protected by a stout cloth, a bucket or basin, a jug and a good supply of water, will, with the camera and necessary chemicals, go far towards furnishing the requisite equipment. I shall now proceed to notice somewhat in detail the various instruments and processes required, presuming in my readers such general knowledge of

* I cannot send these pages to the press without acknowledging the kindness and assistance of my friend Dr. Abercrombie, with whom the memory of many pleasant 'Evenings by Lamplight' will always be associated.

photographic and microscopic manipulation as may be obtained in the ordinary treatises on those subjects.

Camera.—To begin with the camera—which may be described as the dark chamber, extending from the object-glass of the microscope to the screen on which the image is focussed. A stout well-seasoned board, some eight feet in length by fifteen inches in breadth, is selected as a basis of operations (A). This is thoroughly blackened on its upper surface, and fitted with grooves (strips of wood fixed with screws), in which the several supports of focussing screen, microscope, and illuminating apparatus, may run evenly and with accuracy. The woodwork of an ordinary camera, or that portion of it which holds the focussing glass (C), may readily be obtained without the lens, and at a trifling cost. This is rigidly fixed to a light wooden block (B) at such a height as to place the centre of the focussing screen in the axis of the microscope, which is levelled horizontally, and secured by movable clamps to a sliding board at the opposite end of the base-board (A).

Two blackened slips of wood diverging from one another are connected by cross-pieces, so as to form a light triangular framework (F); and this, resting with its base on the camera (C), and with its apex on the microscope, affords support to a double fold of cotton velvet (G), which (pile side inwards) is thrown over all. The cloth is then carefully tucked in at all points, and its junction with the microscope effected by a layer of cotton wool closely applied to the tube, round which the velvet is readily secured by an indiarubber band or thread. Every screw-head and reflecting portion of brass-work must be thoroughly coated with a dead black varnish, and when the necessary diaphragms have been inserted, the camera is ready for use. The whole may be supported on trestles (T), or mounted on an ordinary table; it will practically, however, be found convenient to place it in some spare room, if such is available, where all may be left undisturbed from day to day; for much time is lost, and much experimental work wasted, if the whole has to be arranged *de novo* for every evening's work. Many improvements might be suggested on the form of camera which I have described, such as the bellows arrangements of Professor Rood* and of Dr. Maddox, or some modification of Mr. Highley's long box camera; but these are attended with expense, and, though they add to the convenience, do not in any way increase the efficiency of the instrument.

Focussing Screen.—The focussing screen is best made of a piece of good glass, coated with collodion, sensitised in the usual way, and protected by a solution of tannin. The film thus

* *Transact. Microscopic. Soc.* vol. ii. N.S.

obtained gives a most perfect surface, and the finest definition may be distinguished upon it with ease.

Microscope.—Microscopes are, of course, endless in variety, and it would be digressing too far from my subject to enter on any description here of those supplied by different makers. The one we have used is a Smith & Beck, with stage, sub-stage, and rack movements; but a good lens is the really essential part, all else *may* be supplied with the aid of a little skill and ingenuity. Screw stage-movements, however, are of very great assistance, and I scarcely see how they can be dispensed with altogether when fine work is attempted with a high objective. Supposing an instrument resembling that in the plate at H, the whole should be mounted on a light block (U), at such a height that, when levelled horizontally, and accurately centered, a light thrown through the lens of the object-glass may form a rounded disc in the centre of the focussing screen at all lengths of the camera. If the eye-piece is to be removed—and we have always found it advisable, even at the expense of working at a longer camera—a tube of black velvet must be introduced into the body of the microscope in place of the draw tube, together with one or two diaphragms (D) cut out of tin, and carefully coated with black.

No care should be spared in obtaining perfect blackness within the camera. Stray light from any reflecting point will give the greatest trouble; and this source of fogging may escape notice for a long time if all is not made secure before the commencement of regular work.

The Lens.—I have said that the lens should be a good one, and some explanation will be needed on this point, for the qualities most prized by the microscopist are not always those which are most useful in photographic work. For the latter, the older lenses with small angle of aperture and great penetration are for all ordinary objects preferable to the most recent improvements with large angle and perfection of definition in a flat field: a fair definition over the whole picture is of more value than the minutest detail over a few isolated points which happen to lie in a common plane. Keeping this in view, it will further be advisable to use the lowest power which will give the required detail, and to sacrifice light by lengthening the camera rather than run the risk of losing the penetration which the lower objective will afford. But whatever the lens, it will still be imperfect for photographic purposes, as I shall presently explain, and this imperfection will be found to vary inversely as the power of the objective. In passing through an ordinary lens, the component parts of a simple ray of light are variously refracted—the chemical or actinic rays of the spectrum, violet and invisible, being brought to a focus at a point nearer to the

lens than the yellow and red rays which make up the visual image seen upon the screen.

This chromatic aberration must, of course, be corrected in the best objectives by the proper combination of glasses with varying refractive powers; but, unfortunately for photographers, they are, invariably in the lower powers, overcorrected to compensate for some undercorrection in the eye-pieces, so that, instead of finding the actinic focus at a point nearer to the lens than that of the red and yellow rays, it is actually thrown farther off, and lies at some point beyond the image which is focussed on the screen.

Various plans have been suggested for readjusting this difference, but the simplest and least costly will be presently described under the head of "turning out," by which the distance between the visual and actinic focus is accurately ascertained for each separate lens.

Coarse Adjustment.—When there are two adjustments attached to the microscope, it will be found advisable to reserve the coarser exclusively for focussing the object, and to leave the fine screw for the equally delicate operation of compensating for the difference of visual and actinic foci. Of course, in a long camera both screws are far beyond the reach of the hand when focussing; but a very simple contrivance will enable the operator to obtain the greatest possible delicacy. A stout brass wire (K) is bent round at one end so as to clip firmly the milled head of the coarse adjustment (I); a lever is thus obtained, the distal end of which will move through an appreciable space for the minutest variation of focus. To this lever, a long wooden rod (L), reaching to the focussing screen, is attached by a loop of wire, with a small piece of perforated cork below to support and keep it in place.

Fine Adjustment.—The fine adjustment will be found of great service in recording the differences of actinic and visual foci, especially in the higher powers when minute variations are met with. To mark these with certainty, a small dial plate of card (M) is attached to the body of the instrument, on which a fine wire index bent to clip the milled screw-head of the fine adjustment, and traverse with it, will measure the slightest alteration.

Condensers.—Passing backwards in order, the next portion of the instrument which must be noticed is the condenser. For some purposes we have found an ordinary bull's-eye lens of some 3-inch focus answer very well, but for the higher powers a greater condensation of light is required. Reade's hemispherical drum is a useful form of glass; by it the light is quickly centred and adjusted, whilst its very complete system of stops, throwing rays of light in any given direction, bring out the markings of Diatomaceæ and other test objects with the greatest facility. The ordinary achromatic condenser sold with most

good instruments may be employed, or an objective just lower than the one in use; and we have found this (N) with Reade's drum (O), the latter having its convex side to the source of illumination, a most excellent combination, giving the very best results.

Illumination.—The instrument being now complete, a source of illumination must be decided upon. Many substances have been used, but our own experience has been confined to oil, oxycalcium, and magnesium. The first is of course weakest in actinic rays, but very good results were obtained with it up to 150 diameters. Wet plates were kept moist during long exposures, sometimes reaching to forty minutes, by means of a small cup of hot water inserted within the camera. A solar burner was employed; and though we have long deserted it for the more brilliant magnesium, it is still found useful and economical for adjusting the light and the more lengthy process of focussing. The oxycalcium light gave excellent results even at the higher powers, but the process of making oxygen was tedious, and the apparatus is costly. I can scarcely think that it would be used now that the more actinic light of magnesium is within the reach of every one. After some little experience with the magnesium wire, we have the most sanguine expectations of its ultimate usefulness. With a proper concentration of the light, a few flashes are sufficient to produce a picture even with a $\frac{1}{2}$ object-glass. The light fails only in steadiness, and if some means could be devised for burning the metal uniformly and at a fixed point nothing would be left to desire. The method we have adopted for burning the ribbon is as follows: a small telescope upright of brass (S) regulated by a screw, is fixed to a block (V) adapted to slide on the support (U) common to microscope and light. At the apex of the brass upright is fixed a small tin gutter or pipe of sufficient capacity to admit the wire easily, and directed downwards at an angle of 45 degrees.

By this simple contrivance the point of the wire may be raised or depressed at pleasure, and it will be found a great assistance in ascertaining the best point of illumination to provide a movable stop of tin (P) with a pinhole aperture, which can be attached to the boot of the condenser during this preliminary but very important operation.

The apparatus may now be supposed to be complete; improvements will suggest themselves to anyone who seriously takes up the art of photomicrography; but it is only after a series of trials and many failures that certainty in the results can be obtained. Some directions will be necessary as to the mode of using the various instruments which have been described.

In using artificial light, many difficulties incidental to sunlight exposures are got rid of, but new troubles arise. In place

of having too much light, barely enough can be obtained, and no means of concentrating it are to be neglected.

I will suppose magnesium to be the light employed; the point at which the wire is to burn must be carefully adjusted so that the ignited portion, about a quarter of an inch in length, may be exactly opposite the pinhole stop (P), and give a clear and even disc of light on the focussing screen at any length of camera. The next point is the arrangement of the condensers, and on this head little can be said to lighten the trouble of experiment. Probably every object will require some variation in the position of the lenses, and the best guide is the appearance of the image on the focussing screen. It should be evenly illuminated, clear, sharp, and distinct in outline. With the lower powers, probably the highest light attainable short of focussing the flame on the object will be found to answer best; but in representing the finer markings of Diatomaceæ, the light should in general be sacrificed to definition, and this may be done either by placing condensers and diaphragms in such a position as to exclude all oblique rays, which give an illusive brilliancy to the image on the screen, or by cutting off the parallel rays by a central stop, in the one case using the parallel rays of the central pencil only, in the other securing the more marked definition given by oblique rays, which may be thrown in any desired direction by patterns cut out of a pill-box cover, and fixed on to the condenser.*

Before proceeding further, it will be found convenient to settle the lengths of camera which correspond to different degrees of enlargement.

This may be done by placing a stage micrometer as an object, and focussing it by means of the oil-lamp mounted in place of the magnesium wire. The camera is then lengthened or shortened, until the lines on the screen are found enlarged to the required degree. 50, 100, 200, and 400 diameters are useful enlargements, and the length of the camera for these, with the several lenses, should be carefully noted.

"*Turning out.*"—When these preliminaries have been concluded, it will be necessary to prepare the photographic materials, and ascertain experimentally the amount of correction required for each separate lens. Much time will be occupied in this, and the operator's patience will be tried to the uttermost; but no care can be too great, no attention too exact, at this stage of the process—an error here may cause a series of disappointments, extending over weeks or months of work. There can be no certainty in the results unless the "turning out" be ascertained at once and without a shadow of doubt, and faulty

* Cf. *Journal Microscop. Soc.* vol. vi. p. 10.

pictures will be the inevitable punishment of remissness in these tedious but essential preparations.

We have seen that the object-glasses in ordinary use focus the actinic rays behind the screen on which the visual focus is seen; the picture, therefore, if taken at the visual focus, will be distorted in a proportion corresponding to the distance between this and the actinic focus beyond. In the higher powers this distance is so minute that it may practically be neglected; but in the $1\frac{1}{2}$ -inch, the $\frac{2}{3}$ -inch, and the $\frac{1}{4}$, some alteration will have to be made—either the focussing screen must be moved back to the point of actinic focus before a plate is exposed, or, which amounts to the same thing, the object-glass must be moved away from the object, so as to bring the actinic focus into the place of the focussing screen. This is done by means of the fine adjustment, and it will be well to see before commencing that the screw works readily on the slightest movement of the milled head. Many nights' work may be lost, and false results obtained, through neglect of this precaution. The index-needle should be placed at the extreme left of the dial, and moved uniformly in one direction.

The best object to choose for the lower powers is one covered with fine hairs at varying depths, such as the proboscis of a fly, or the tracheal rings of the cricket's tongue may be preferred. A photograph is taken at the visual focus, and it will be found that other hairs than those focussed appear sharp and defined in the negative, whilst those which were sharpest on the screen are hazy and indistinct. If we can recognise any two of these, and ascertain, on looking through the microscope, how great a movement of the fine adjustment is required to alter the focus from one of these hairs to the other—from a hair focussed on the screen to one actually in focus in the picture—we shall have ascertained the correction or "turning out" for the lens in use at the time, and careful note should be made of it, if the result is confirmed by the subsequent test of focussing as before, altering the fine adjustment to the ascertained amount, and taking a picture then which shall correspond in all respects to the focus which had been obtained on the screen.

This appears simple in description, but in practice it is not so. Many experiments will have to be made, picture after picture will have to be taken before the portion focussed on the screen finds its exact counterpart on the collodion film. As some slight guide to the beginner, I may mention that our $1\frac{1}{2}$ -inch Smith & Beck required $\frac{8}{10}$ of a revolution of the fine adjustment-screw; a $\frac{2}{3}$ -inch by the same makers required $3\frac{1}{2}$ of the divisions marked on the card dial, equivalent to $\frac{7}{10}$ of a revolution; a $\frac{1}{10}$ -inch Smith & Beck required one division on the

dial, or $\frac{1}{10}$ of a revolution; a $\frac{1}{2}$ Smith & Beck required $\frac{1}{20}$ of a revolution; a Ross's $\frac{1}{8}$ -inch required $\frac{1}{40}$ of a revolution; and in a Powell & Leland's $\frac{1}{12}$ -inch the visual and actinic foci were found practically to coincide. These are but rough guides. The same powers by the same makers differ widely in this respect, and nothing but direct experiment in each case can decide the amount of correction required. As if these difficulties were not sufficient, it has been asserted that each separate light requires a different degree of correction; but in our experience the difference, if any, for oil, magnesium, and oxycalcium lights is so small that it may safely be disregarded.

Screw Collar.—One small, but not unimportant, matter still requires to be noticed before proceeding to take the picture. In using the higher powers, the screw collar will be found a constant source of perplexity, and it is not easy to give any clear rules for its adjustment. Perhaps the best plan is to ascertain the most advantageous position with a low eye-piece before arranging the camera, and then to take the picture at that; of course, allowing as before for the amount of correction which the lens requires. If the result is not quite satisfactory, some attempt may be made with the screw collar to improve the focus on the screen.

Of the photography I shall say little or nothing, as it does not materially differ from the processes in ordinary use; but I may observe that, if care, and cleanliness, and delicacy are requisite for ordinary work, they are infinitely more necessary where lines numbering fifty or sixty in the $\frac{1}{1000}$ part of an inch have to be represented clear and distinct on the film and transferred to paper.

The operator must tread lightly, or the focus will be disturbed; he must be still, or dust will rise; the smallest things must constantly be attended to, or the results will not equal his just expectations.

I shall conclude this paper by shortly going through the process of taking a photograph of any object, say one of the finer Diatomaceæ.

The camera is arranged, I will suppose, as represented in the plate—of such length as will give an amplification of 400 diameters with the $\frac{1}{2}$ objective.

First, centre the oil-lamp. Remove carefully the apex of the triangle (F) from the microscope, and let it rest on the base-board at the side; take out the velvet from the tube of the instrument, and insert the eye-piece. It will now be easy to fix on the object; bring it to the centre of the field, and obtain the best possible definition by adjustment of focus, screw-collar, and condensers. When this has been done, the eye-piece is again removed, the velvet tube replaced, and the whole made

lightproof as before. The index on the card (M) is placed well to the left of the dial, the focussing rod is attached, and all is ready for focussing the object. Much care and great accuracy will be required in this process, and a small handglass will be found very useful, taking care to look through it always in the same direction, for the focus on the screen varies materially as we regard it directly in a line with the light or obliquely. My own plan is to hold the lens opposite the centre of the focussing screen (a point marked on the collodion) at a distance of some two inches, then, when the point of light has been caught, to move the eye steadily backwards until the whole object is clearly shown. The focussing rod is now pushed forwards, so as to throw the object nearly out of focus, and gradually drawn back until the point of sharpest definition is reached. In this way no risk is run of focussing the distal side of the object. If the light is now evenly distributed over the object, it will be well to try a few flashes of the magnesium wire, to be sure that it is in the right position. About a quarter of an inch of the ribbon is allowed to protrude beyond the tin trough, and the flame of a small spirit-lamp applied until combustion takes place. If all is satisfactory, the index on the dial is moved on the required amount, say, $\frac{1}{10}$ of a revolution, and all is ready for preparing the plate. This should be of stout "plate," or flatted crown, well roughened at the edges with a corundum file, to secure adhesion of the film during the repeated washings it will have to undergo. One kind of collodion should be selected and adhered to, preference being given to such as will give some toughness of film.

The bath is that in ordinary use. When sensitised, the plate is removed to the camera, and exposed to a number of flashes from the wire, varying with the intensity of the light on the screen and the density of the object. With a good light and transparent object one or two will suffice, whilst in certain cases, where oblique light is used, as many as forty or more will be found necessary to get a satisfactory impression.

During the burning of the light, a green shade or green spectacles afford great relief to the eyes, which, if unprotected, are dazzled and blinded by the brilliancy of the rays.

We have used many developers, all of which answer very well; perhaps the best is as follows:—

Protosulphate of iron, a drachm and a half;
Powdered sugar, half an ounce;
Glacial acetic acid, two drachms and a half;
Distilled water, four ounces.

But it must not be left any length of time on the plate after the image is out, or fogging will invariably make its appearance in the subsequent processes. When the picture is confined by the

diaphragm (D^1) to a portion of the plate, the corners which are cut off should retain a transparency equal to the glass plate itself. The occurrence of a fine dust over these portions, when the intensifying process is complete, shows that the developer has been allowed to remain too long, or that the arrangement of the condensers and diaphragms has allowed too much interference of oblique rays in the picture.

When the image is fully out, and cleared by hyposulphite of soda, its merits can be fully considered. The negative will be weak, in some cases so weak as to discourage the inexperienced from any attempt at intensifying. But very much can be done to supplement the deficiency of actinic power, and there is no doubt that means will eventually be found of doing so to a much larger extent than is now possible.

It will be found useful to vary the mode of intensifying according to the character of the picture. If at a low power, with plenty of light and open definition, it may be got up at once by pyro and silver before clearing; but if at a low light and high power, with lines of extreme delicacy, it is best to clear and dry the film before intensifying by daylight, with iodine, pyrogallic, and silver. In pictures of dead black and white, good results may be obtained by the bichloride of mercury, followed by hydrosulphuret of ammonia, as recommended by Col. Sir H. James, R.E. in the preparation of photozincographs from the ordnance maps. With the "pyro and silver plans" risk is run of filling up the finer lines, and rendering the whole picture woolly.

In printing, care must be taken to get the most perfect contact between the paper and the negative, or much fine definition will be lost in the transfer. Great pressure must be used at the risk of cracking a few glasses from their expansion under heat. The paper should be of the finest grain, and it may perhaps be useful to amateurs whose time is valuable to know that paper sensitised in a bath rendered decidedly acid by the addition of nitric acid (twenty drops to the pint of bath) will keep perfectly well in a dry place for a week or more.

A word may be added on the selection of objects, for success, especially in the earlier essays, will much depend on this.

Yellow or reddish tissues will generally be found very impenetrable to artificial light; but I do not say that they cannot be photographed, for even opaque objects, such as Foraminifera, *have* been conquered by Professor Kingsley. Objects mounted specially with a view to photography should have their colour, if non-actinic, discharged by maceration in some fluid such as chlorine water or strong liquor potassæ, followed by glycerine, varying the solution according to the chemical composition of the object.

The flatness of the object is no less important than the colour. Every part should lie as nearly as possible in one plane. Among vegetable tissues, cells, hairs, ducts, and sections of wood, may be mentioned as good objects. Several of the Algæ, including Diatomaceæ and Desmideæ, may be photographed entire. Specimens from the higher animals would include blood-discs, sections of bone and teeth, epidermal structures, muscular, nervous, and fibrous tissues; whilst among lower organisms, Infusoria, Zoophytes, Sponges and Insects, either entire or in parts, will be found to supply an infinite variety of slides adapted to the purposes of photomicrography. Much trouble will be saved in alteration of screw collar by mounting the Diatomaceæ dry on a thin glass cover. A number of these squares may be kept in a small box made for the purpose, and there will be no difficulty in mounting them when required on a perforated glass or zinc slide by means of a small indiarubber band.

In the foregoing pages, I have endeavoured briefly, and as clearly as the subject will admit, to describe one of the modes by which faithful transcripts of various microscopic objects can be obtained on paper. Of sunlight pictures I have said nothing, but anyone who wishes information on the subject will find it ably treated in an article contained in Dr. Beale's "How to work with the Microscope." It has been my desire to place the art of photomicrography before my readers in the light of an amusement and solace for evening hours, rather than as a study demanding the labour and light of the day; and I am not without hope that some may be induced in their intervals of leisure to take up an art at once so interesting and promising in its results.

REVIEWS.

THE ORIGIN OF SPECIES.*

TO give anything like an adequate analysis of Mr. Darwin's treatise would require a space far greater than that at our disposal. The volume itself is so extensive, the matter it contains is so compressed, and the arguments are so condensed, that nothing short of the book itself could lay the facts in favour of the doctrine of Natural Selection fairly before the public. The present edition is the fourth which has been issued since 1859; and it is not merely a reprint of the one which preceded it, but contains numerous additions and corrections.

Whatever be the accuracy of the theory which Mr. Darwin has so ably promulgated, it is surprising how many distinguished men of science in all parts of the world have given it their support and countenance. In this country, nearly all the naturalists of repute have admitted the force of Mr. Darwin's opinions; and though few of them are prepared to swear to the truth of the new doctrine, all are ready to admit that the hypothesis of Natural Selection has far more evidence in its favour than any other upon the same subject that has yet been published, and that, furthermore, it is in no way obnoxious to the facts of revelation. Among the more formidable opponents to Mr. Darwin's opinions is Professor Owen; at least, we may say *was*, for we are at present in considerable difficulty as to the formation of an idea concerning Professor Owen's views. And yet it seems as if the superintendent of the British Museum inclines towards the Darwinian theory, though he does not feel that he ought to adopt it. It was only through a recent letter of Professor Owen that this mental condition displayed itself. In May last an important notion of Professor Owen's treatise on Comparative Anatomy appeared in the pages of the *London Review*, in which the writer criticised with some severity, but with much justice, Professor Owen's comments on the theory of Natural Selection. To this review Professor Owen replied in a long and able letter, in which, among other statements, he remarked that, "No naturalist can dissent from the truth of your perception of the essential identity of the passage cited with the basis of that [the so-called Darwinian] theory, the power, viz., of species to accommodate themselves or bow to the influences of surrounding circumstances." This was quite sufficient to show that Professor Owen desired to be considered the author, or at least the suggestor, of the theory

* "On the Origin of Species by Means of Natural Selection; or the Preservation of Favoured Races in the Struggle for Life." By Charles Darwin, M.A., F.R.S. Fourth edition. London: Murray. 1866.

of Natural Selection ; but a passage further on in the same letter places the matter beyond all doubt ; in it Professor Owen speaks of himself as " the author of the same theory (Darwinian) at the earlier date of 1850." Clearly, whatever be Professor Owen's opinion as to the expediency of admitting the new theory, he at all events desires it to be thought that he anticipated Mr. Darwin in suggesting the basis of the Darwinian doctrine. Still it is tolerably clear, as Mr. Darwin has shown, that at the very time when Professor Owen alleges that he first suggested the essential principle of the theory of Natural Selection, he really denied that principle in the most unequivocal manner. The Professor states that he first gave the scientific world the idea in a paper read before the Zoological Society in 1850 ; but the following quotation from this memoir proves that Professor Owen at the time he put the theory forward (?) failed to understand its very essence. In this paper he said, " We have not a particle of evidence that any species of bird or beast that lived during the pliocene period has had its characters modified in any respect by the influence of time or of change of external circumstances."

It may be gathered, therefore, from the foregoing passage that the most formidable if not the only serious opponent of the Darwinian theory now wavers between the old and the new hypotheses. This circumstance seems to us of importance, because it shows that nearly all those who are capable of forming an opinion upon the subject side with Mr. Darwin.

As to the argument in support of the Darwinian hypothesis, there is little to be said that has not already in various forms been laid before our readers. The great principles on which the doctrine is based are, the tendency of what are called species to vary, and the tendency of external conditions to destroy all those individuals which have not sufficient natural protection. Thus, let us say that in any litter of animals there are certain individuals provided by the law of variation with appendages, offensive or defensive, which adapt them to the climate in which they live, or serve to give them more protection from the attacks of animals which prey on them, than is afforded to their fellows ; it is clear that those individuals will in the ordinary struggle for existence, which every organism must go through, have a greater chance of protection, and hence of perpetuation, than their brethren. Thus, the stronger individuals—or, in other words, those best adapted to the conditions under which all are situated—live ; and so with their successors : those of them possessing the parental characters of adaptation in the highest degree will crush their fellows to the wall and survive them ; and thus an insignificant anatomical feature may become in ages a very important one, and species having different characters from those of the fortunate race become swept away or destroyed. The reader, however, will naturally raise this objection, Why do we not find intermediate forms ? This is certainly a very difficult question to reply to, but still it can in part be answered. It may, for example, be urged that Geology affords us to some extent a series of connecting links of great value ; and more than this cannot be expected, for every geologist must admit that never-ceasing denudation has annihilated the Geologic Record. Again : the period of time required for the transition from one specific form to another is so great as to render it quite intelligible why the connecting links exhibit themselves

as mere varieties. But if it be thought that at least all the connecting link^s between any series of forms ought to be present, if not in the fossil at least in the living state, it should be remembered that the very process of natural selection prevents this, each succeeding variety crushing out that which preceded it, because in this struggle for life it has the greater number of advantages. Two elements, however, in the argument are well sustained in the following passages. The first relates to the certainty of the struggle for existence :—

“There is no exception to the rule that every organic being naturally increases at so high a rate, that if not destroyed, the earth would soon be covered by the progeny of a single pair. Even slow-breeding man has doubled in twenty-five years. At this rate, in a few thousand years there would literally not be standing-room for his progeny. Linnæus has calculated that if an annual plant produced only two seeds, and there is no plant nearly so unproductive as this, and these seedlings next year produced two, and so on, then in twenty years there would be a million. The elephant is reckoned the slowest breeder of all known animals, and I have taken some pains to estimate its probable minimum rate of natural increase: it will be under the mark to assume that it begins breeding when thirty years old, and goes on breeding till ninety years old, bringing forth three pair of young in this interval; if this be so, at the end of the fifth century there would be alive fifteen million elephants, descended from the first pair.”

The second passage which we quote from Mr. Darwin, shows in a popular manner, which must appeal to the reason of every ordinarily intelligent person, what an enormous length of time is required in order to produce even a moderate degree of variation, and bears forcibly upon the question which the opponents of Natural Selection so often put, “Why do we not find intermediate forms?”

“No one would expect to raise a first-rate melting pear from the seed of the wild pear, though he might succeed from a poor seedling growing wild, if it had come from a garden stock. The pear, though cultivated in classical times, appears, from Pliny’s description, to have been a fruit of very inferior quality. I have seen great surprise expressed in horticultural works at the wonderful skill of gardeners in having produced such splendid results from such poor materials; but the art has been simple, and, as far as the final result is concerned, has been followed almost unconsciously. It has consisted in always cultivating the best known variety, saving its seeds, and when a slightly better variety has chanced to appear selecting it, and so onwards. But the gardeners of the classical period, who cultivated the best pear they could procure, never thought what splendid fruit we should eat; though we owe our excellent fruit in some small degree to their having naturally chosen and preserved the best varieties they could anywhere find.

“A large amount of change in our cultivated plants, thus slowly and unconsciously accumulated, explains, as I believe, the well-known fact, that in a vast number of cases we cannot recognise, and therefore do not know, the wild parent stocks of the plants which have been longest cultivated in our flower and kitchen gardens.”

The phenomena which have been grouped together under the term *Instinct* have been a powerful weapon in the hands of those who combat the Darwinian doctrine. It is interesting, therefore, to observe how the author deals with this part of the subject. In trying to account for the instincts of animals, Mr. Darwin takes two courses: first he endeavours to show how, by the law of natural selection, what is called instinct is little more than *Acabit*,

arising accidentally and perpetuated; secondly, he attacks many of the remarkable instances of so-called instinct, and destroys much of their force. As regards the supposition that instinct is inherited habit, there seems every reason to think that Mr. Darwin's view is the correct one. It is impossible for the physical philosopher to deny that every organism has the power of calling into play, or allowing to fall into disuse, any one of the greater number of its parts or faculties, and it is equally impossible to deny the truth of the proposition that such parts as are thus called into action descend to future generations. Now, since even in the case of mental impulses, each action of the brain must be accompanied by a corresponding change of substance, it is clear that in this way accidental variations of mental operation may be rendered permanent, and thus allowed to descend from one generation to another. We may therefore in this manner account for many of the most puzzling examples of instinct. And when we remember that animals under domestication lose most of their wild instincts and acquire a new series as the result of *artificial selection*, the analogy between the effects of natural selection and instinct on bodily structure ceases to be a difficult one.

Having analysed very fully the nature of instinctive actions, Mr. Darwin proceeds to show that the instinct of the bee to form wax from flowers is by no means a perfect one, for these insects will prepare the comb from various artificial substances, such as "wax hardened with vermilion and softened with lard," "a cement of wax and turpentine," "oatmeal," &c., &c. He then makes the following remarks on the nature of the cuckoo's instinct:

"With respect to the last point insisted on, namely, of the young European cuckoo ejecting its foster-brothers, it must first be remarked that Mr. Gould, who has paid particular attention to this subject, is convinced that the belief is an error; he asserts that the young foster-birds are generally ejected during the first three days, when the young cuckoo exerts by its hunger-cries, or by some other means, such a fascination over its foster-parents, that it alone receives food, so that the others are starved to death, and are then thrown out, like the egg-shells or the excrement, by the old birds."

We heartily wish we had space to make further quotations from this admirable volume; but since we must leave the book for the present, we would earnestly urge all our readers, whether naturalists or not, to take it up and read it carefully. There is not a trace of special pleading in the whole argument from beginning to end; it is an able and honest exposition of facts and of the inductions naturally formed upon them. It is the work of one of the most accurate and experienced observers of the age, and cannot fail to enlighten even those whom it cannot convince.

ELECTRICITY FOR STUDENTS.*

DR. NOAD, the well-known author of a *Manual of Electricity*, now presents the student with a closely-printed volume of more than five hundred pages on the same subject. It is a most elaborate compilation of

* "The Student's Textbook of Electricity." By Henry M. Noad, Ph. D. F.R.S. F.C.S. Lecturer on Chemistry at St. George's Hospital. With four hundred illustrations. London: Lockwood and Co. 1867.

the facts of electricity and magnetism, and of the theories which have been advanced concerning them. It is quite refreshing to go over its pages after putting down English translations of French works on the subject, and other works too evidently, though not admittedly, borrowed from our continental neighbours. For in its pages we find accounts of the researches and speculations of our own philosophers, and proper importance given to their labours. Not that there is any confessed or apparent effort of the author in this direction, but merely that it is a genuine compilation by a man versed in the literature of his subject. We have often felt pained to see English students with textbooks in their hands which leave the vast stores of philosophical knowledge contributed by their countrymen to the general stock unnoticed, and to know that there was no truly English textbook sufficiently comprehensive to offer in place of them.

The work is arranged in ten parts, one of which, filling a quarter of the volume, is devoted to the electric telegraph. The chapter in the first part, on atmospheric electricity, will be found very interesting. In it and the chapter on marine telegraphy, Professor William Thomson's beautiful electrometers are described, viz. the divided ring electrometer, the common house electrometer, and the portable electrometer. One important use of the first and last of these is the testing the insulating power of the insulating coat of short lengths of marine telegraph cable. This testing consists in estimating the rate at which the tension of a given charge of electricity communicated to the wire diminishes. We shall not attempt to describe these electrometers, but content ourselves by stating that the indicating needle is kept in metallic communication with the inside of a charged Leyden jar, by which its attraction and repulsion for the two manifestations of electricity in bodies is rendered much more sensitive and much more certain under the slight leakage of electricity which always takes place; that the needle oscillates over two half rings of brass (the divided ring), one in connection with the earth, and the other with the charged cable or other body to be tested: and lastly, that for continuous observation of the electric tension of the atmosphere, the motions of the needle are recorded by the photographic action of the light of a lamp reflected by a mirror connected with the needle, upon a cylinder covered with photographic paper and rotated by clockwork.

Dr. Noad gives us full accounts of even the most recent additions to our knowledge of the subject of which he is treating. His account of the telegraph is exceedingly interesting. The descriptions of the many instruments he has to notice are usually very clearly drawn out, and a comprehension of the text is materially simplified by the introduction of numerous woodcuts.

The enunciations of fundamental principles, and the definitions of terms, are, as a rule, usually unsatisfactory in a scientific point of view. Even these, however, are generally compiled from the writings of others, as stated by Dr. Noad himself. But the compiling here, as elsewhere, is a remarkable proof of the comprehensive and philosophical way in which the author handles his subject. And we venture to say that seldom has a scientific writer been more happy in throwing into a treatise on a given subject the most important of the investigations and the most correct of the views of the workers at it. Every student of physical science will undoubtedly be glad to possess it.

THE ELEMENTS.*

METEOROLOGY gives promise of being as popular a pursuit as either Natural History or Astronomy. Everybody nowadays is more or less a meteorologist. Wherever we go we find that people begin to understand the advantage of systematic and daily observation of the barometer and thermometer, and those who appreciate the employment of the hydrometer and ozone-test are by no means few in number. Indeed, meteorology is fast becoming a science, and if the progress made in observation and induction during the next ten years be equal to that which the past ten years has brought forth, it will be a science of no mean degree of exactness. Our readers must not, however, conclude from what we have stated that there is much of perfection in meteorology as we yet know it. There has been too great a tendency on the part of the general public to overrate the importance of the late Admiral Fitzroy's weather-forecasts, and to place an implicit reliance upon all the predictions of the Meteorological Department of the Board of Trade. This has been a serious error, for it has in some measure prevented the degree of careful research which is the result of an uncertainty concerning the nature of phenomena. Is it not likely that many people gifted with scientific tastes would have selected the pursuit of meteorological knowledge had they known how impossible it was to frame definite predictions concerning the weather? The real facts of the case are: (1) that at the present moment weather-forecasts are almost an impossibility; and (2) that this inability to predict arises from the absence of a sufficient number of established facts on which to frame exact generalisations. In this condition of meteorological science, we therefore look anxiously for any work which promises to throw light on such serious problems as those of oceanic and atmospheric currents. Not unfrequently are we disappointed, and we are sorry to say that in the treatise before us we have met with nothing likely to add to the facts or the inductions which meteorologists are already familiar with. Mr. Jordan presents us with one, amply illustrated, and, were it not for a little indulgence in the grandiloquent and teleological claptrap so much admired by inexperienced authors, a really well-written volume. It, however, contains little of any practical value. The author denies the ordinary theories of the tides, and maintains that the centripetal force of Newton is attraction proceeding from solar gravitation, and that the centrifugal force of the same philosopher is simply attraction proceeding from astral gravitation. Mr. Jordan considers that evaporation has much to do with the production of oceanic currents, but he regards the tides as being dependent upon a larger and more complex series of conditions. It is a matter of some difficulty to grasp the author's views and arguments with much clearness; but so far as those concerning the tides have been tabulated by him, they are as follows:—(1) The great unchanging force which holds the water down on the earth's surface is the

* "The Elements: an Investigation of the Forces which determine the Position and Movements of the Ocean and Atmosphere." By W. L. Jordan. Vol. I. London: Longmans and Co. 1866.

power of gravitation contained in the earth. (2) The lesser influences which modify the position it would assume under the influence of that gravitation alone are:—(a) the centrifugal force caused by the rotation of the earth on its axis; (b) the power of gravitation contained in the sun and the moon; and (c) the force which acts in opposition to the attraction of the sun and the moon. Of these lesser forces the centrifugal force is, like the gravitation of the earth, fixed and steady. The other lesser influences are constantly changing their direction, thereby causing that constant changing of the position of the water which forms the tides. Such is briefly Mr. Jordan's theory, and we leave it and its author to the consideration of our readers.

CHOLERA TREATED BY ICE.*

DR. JOHN CHAPMAN, whose efforts to introduce ice as an important therapeutic agent, and whose experiments upon the effects of ice in the treatment of nervous affections are so familiar to the public and the profession, has given us a treatise on Cholera, which certainly deserves notice. We shall not say whether, in the present state of our knowledge of the conditions under which cholera appears, Dr. Chapman is justified in putting forward so detailed an hypothesis as that which he advocates, but we must confess that, whatever amount of truth it may possess, his view is worked out with a display of logical reasoning, formidable facts, and erudition such as is seldom met with in medical essays. In noticing the work before us, we must do so from two aspects; we must first consider Dr. Chapman's explanation of the cause of cholera, and, secondly, we must examine into the character of his mode of treatment. The first is by far the most interesting point. Dr. Chapman thinks that the chief cause of cholera is external heat, which, by acting upon the nervous centres, increases the quantity of blood supplied to them, and thus brings them more powerfully into action. It is known from the experiments of Bernard and other writers that, when the sympathetic nerve-centres are stimulated, those of their branches supplying the bloodvessels cause these latter to contract. Another physiological fact is that, when a secreting surface has its ordinary blood-supply slightly diminished, it throws off a larger quantity of fluid than usual. Connecting these two well-known laws, Dr. Chapman frames an argument somewhat in the following manner: Heat applied to the back stimulates the sympathetic nerve; stimulation of the sympathetic, causes contraction of the bloodvessels of (among other parts) the intestinal canal; the diminution in supply of blood thus produced causes increased secretion of mucus, and finally increased secretion of mucus brings on diarrhoea. Thus we see the conclusion is very excellently reasoned out; but is Dr. Chapman quite sure of his premisses? Has he ever produced true choleraic symptoms in animals, let us say, by the application of heat to the spine?

* "Diarrhoea and Cholera: their Nature, Origin, and Treatment through the agency of the Nervous System." By John Chapman, M.D. M.R.C.P. M.R.C.S. 2nd edition, enlarged. London: Trübner & Co. 1866.

Has he been able to adduce a single undoubted instance of cholera produced by the action of external temperature? If not, then he is hardly warranted in denying the evidence already accumulated in support of the contagion and poison theories. The next point to be noticed in Dr. Chapman's book is that which refers to his treatment. The author, believing that the action of heat in the spine is the cause of cholera, considers that ice applied over the sympathetic centres is the only reliable remedy in cholera cases. Of course, if we admit Dr. Chapman's conclusions as above, we cannot deny the truth of his proposition that ice is the sheet-anchor of remedial agents in cholera; but, as we have already said, we do not think that the author's argument rests on a sound basis. However, it is interesting to see what are the results of his practice, and we beg to refer our readers to Dr. Chapman's volume for a most conscientious report on this part of the subject. We cannot say that the proportion of recoveries is anything very surprising, but our readers will judge for themselves on this point. One thing must be admitted; that of the hundred and one treatises on cholera which have been published during the past year, Dr. Chapman's is at once the most interesting, the most scientific, and the most scholarly.

MODERN CHEMISTRY FOR STUDENTS.*

TO anyone but an eager follower of the study of chemistry, Dr. Frankland's book must appear very repulsive; and did we not know what numbers there are devoted to this wondrous science, we should quake for the result to the enterprising publisher who issues it.

The object of the work is to free the attendant at the Professor's lectures from the necessity of taking notes of the matters brought before his notice, and so to prevent distraction from much that is being uttered, in order to have a record of the rest. All descriptive matter—at least nearly all—is omitted, as being within the student's reach in other treatises; and the work mainly consists of explanations, in symbolical language, of the chemical changes by which bodies are produced and by which they pass into others. The modern atomic weights are employed, but the notation is peculiar to Dr. Frankland, though now before the chemical world, to a certain extent at least, for some years. In the symbolical formulæ of a body, our distinguished author endeavours to represent at a glance, to the initiated, a synopsis of its chemical properties. The formulæ are also expressions of ascertained facts concerning the body, and but little hypothesis. The typical formulæ of Gerhardt have been found valuable to chemists, because they represented, to a considerable extent, the number of atoms of one element necessary to meet the combining power of another, thus furnishing an explanation of the faculty of atoms of becoming linked into complex groups.

* "Lecture Notes for Chemical Students; embracing Mineral and Organic Chemistry." By Edward Frankland, F.R.S. &c. Professor of Chemistry at the Royal Institution of Great Britain and in the Government School of Mines. London: Van Voorst, 1866.

Dr. Frankland has gone still further in this direction, and his formulæ fully represent the many links by which the elements of a complex body are united together. Many of these look very complex, but much of their complexity disappears when the principle of the system is mastered. Moreover, the formulæ are simpler than the "mixed type" formulæ, besides being much more perfect expressions of the constitution of bodies.

The new system of nomenclature becoming rapidly adopted by chemists is also a feature in the volume.

A BOOK ON BONES.*

IT would of course be out of place in these pages to give anything like an analysis of Mr. Norton's excellent treatise on the Human Skeleton. We shall therefore confine ourselves to a short notice of the general character of the work. Of the importance of an accurate knowledge of the minute features, connections, and relations, of the bones which form the framework on which the animal body is built up, there cannot be the faintest doubt. The difficulties in the acquirement of this knowledge are familiar to all who have begun the study of anatomy. To the surgeon, as well as to the physician, an exact acquaintance with the positions and forms of the several bones, and of their relations to the soft parts which surround or are enclosed by them, is absolutely essential. But the study of the bones is anything but a fascinating pursuit, and the works that have from time to time been published have not removed the obstacles besetting the student's path. In the admirable volumes on our table, the state of things is different; accuracy and terseness of description, simplicity of exposition, and an avoidance of all that prolix illustration which some authors have indulged in, characterise Mr. Norton's essay. There is, too, a further advantage which this book possesses over its predecessors, and this advantage is twofold: the plates are arranged in atlas form, and constitute a separate volume, and they are executed with a degree of artistic beauty and scientific truthfulness which cannot fail to elicit the warm admiration of the student, and the honest recommendation of the professional press.

ESSAYS ON ENGINEERING TOPICS.†

MR. FAIRBAIRN has collected together, as a third series of essays, his lectures on the Applied Sciences and on other kindred subjects, and his treatises on the comparative merits of the Paris and London International

* "Osteology; a Concise Description of the Human Skeleton, adapted for the Use of Students in Medicine." By Arthur Trehern Norton, Assistant Lecturer and Demonstrator of Anatomy, St. Mary's Medical School. London: Hardwicke, 1866.

† "Useful Information for Engineers." Third series. By William Fairbairn, Esq. C.E. LL.D. F.R.S. &c. London: Longmans, Green, and Co. 1866.

Exhibitions, on Roofs, on the Atlantic Cable, and on the effect of Impact on Girders. The work will no doubt be found acceptable reading enough to some of our readers, most of whom are probably familiar with the style of the well-known engineer. The several matters discussed hardly admit of any useful reviewing, so we shall content ourselves with a brief statement of what they are, in order that the reader may form some idea of the interest of the series to himself.

The lectures are "almost exclusively intended for the moral and intellectual improvement of the engineer and artisan." There is a lecture on the Applied Sciences, and another on the Present State of Progress in Science and Art. The former is almost entirely about steam-engines and the manufacture of cotton; the latter has a broader grasp, and in places is of some interest. There is next a lecture on Labour, its Influences and Achievements, and after that one upon Literary and Scientific Institutions, the nature of both of which can be sufficiently divined from their titles. Another lecture is a sort of Humboldt's *Cosmos* in twenty pages. It includes an account of the experiments of the author conjointly with Mr. Hopkins and Dr. Joule, and has since received from the author the somewhat odd title of *On First Principles and the Thickness of the Earth's Crust experimentally considered*. One other lecture is on Iron and its Appliances, and treats of the use of iron in the construction of steam-boilers and of machinery and ordnance. The essays on the Atlantic Cable, on Roofs, and on the machinery of the International Exhibitions, are of general interest.

THE MANAGEMENT OF STEEL.*

THE present edition of Mr. Ede's little book is so much enlarged as to be almost a new work. We have scanned its pages with much interest. It could hardly have been supposed that such a readable book could be written on such a subject. Few would find it fail to wile away a spare hour or two. Expanding the title a little, the matters discussed in the volume are the manufacture of iron and steel, the choosing of steel for tools, forging iron and steel, annealing cast-iron and steel, hardening and tempering of cast-iron and steel, expansion and contraction of steel, shrinking of iron and steel, the case-hardening of wrought-iron, and the toughening of mild cast-steel for guns, shot, railway bars. The whole is written in homely language, which runs pleasantly enough, notwithstanding the not unfrequent deviations from grammatical requirements. The work is so comprehensive in its details that it must prove, we think, extremely useful to anyone interested in the subject. An extract will probably give a better idea of it than any further comments from us:—

"The water which is to be used for hardening steel tools, or any other kind of articles made of steel, should never be quite cold, but should have,

* "The Management of Steel." By George Ede; employed at the Royal Gun Factories' Department, Woolwich Arsenal. Fourth edition, revised and enlarged. London: William Tweedie, 1860.

as the term is, the chill taken off; or, to use other words, the water requires to be made a few degrees warmer. The reason for this is, that when water of too cold a temperature is used, it abstracts the heat so suddenly from the surface of the steel, that it causes a too sudden contraction of the surface steel, and the expansion of the interior steel in its red-hot state is more than the hardened crust can bear; consequently it frequently causes the steel to break.

"It is quite probable that the interior steel for the moment becomes both heated and expanded in a higher degree by the sudden compression, for the sudden contraction of the surface steel by the sudden loss of heat must act on the interior steel something similar to a blow from a heavy hammer on the pressure of a squeezer; and if the steel should happen to be a little too hot at the time of dipping it into pure cold water, there is as much danger of its breaking as there is of a glass bottle breaking when boiling water is poured into it: heat and cold act on glass and other brittle substances in a similar manner that they act on steel. When boiling water is poured into a glass bottle, the expansion of the inside glass is so sudden that it is more than the outside can bear; consequently the bottle breaks. If glass is heated to a red heat and plunged into cold water, it breaks into a quantity of small pieces from the sudden contraction; if a stone is thrown into the fire, it breaks from the sudden expansion of its surface."

BRITISH SPONGES.*

IN one of our last numbers we noticed the first volume of Dr. Bowerbank's Monograph, and we spoke of it as a work which every naturalist interested in the study of the Protozoa ought to become acquainted with. But there were other features in the first volume which gave it a special importance over the part now issued: it dealt very fully with the general anatomy and physiology of the Amorphozoa. In volume ii. we find merely a continuation of the description of genera and species; this, which was begun in the first part, though of little interest to the physiologist or the general zoologist, is to those who are engaged in the pursuit and identification of species simply indispensable. The descriptions complete the account of the British Sponges, and are more comprehensive and detailed than those of any other systematic treatise we are familiar with. The author, in the first instance, gives a classified list of all the species described in the volume, ranging them, according to their affinities, in orders and suborders. In giving an account of the species, he first supplies the characters in true technical fashion; as, for example, in the case of *Grantia compressa*, he begins thus, "Compressed, foliaform, slightly pedicelled, surface even, armed with flecto-claval spicula." Then he pursues the happier and—for the general reader—more satisfactory method of giving a long general description of the sponge, in which all the striking points in its external anatomy are given in familiar language. The present volume contains no plates, but the descriptions are lucid and comprehensive. In the first volume, Dr. Bowerbank gave a tabular view of the systematic arrangement of sponges,

* "A Monograph of the British Spongiidæ." By J. S. Bowerbank, LL.D. F.R.S. &c. Vol. II. London: Published for the Ray Society by Robert Hardwicke, 1866.

and in this he included the exotic as well as the native genera. His reason for combining the two in the one classification was a belief that some of the species of exotic sponges would before long be found among our British sponges. Strange to say, this idea of the author's has since been realised; for he has himself, since the publication of his first volume, added two species of *Ecionemia* and one of *Ophilitaspongia*, an entirely new genus, to our list of British species. Dr. Bowerbank offers some useful remarks on the identification of sponges; generally speaking, he says there is no great difficulty in the determination of the genus, "but in some cases more than ordinary caution is necessary in the examination of the specimen under consideration." He especially cautions the student against the examination of sponges by the naked eye alone, for it happens that in many cases the author has been unable to make a first identification until he had submitted the structure to minute microscopical examination. Dr. Bowerbank's second volume completes his first one, and the two parts form a work which is creditable to its author and to the useful society which has published it.

WELLS ON DEW.*

FEW of our readers can have failed to have seen reference to Wells' Essay on Dew, so much eulogised as a splendid example of experimental research and philosophical induction. Mr. Casella has done good service to the scientific public in putting again within their reach copies of this esteemed work. Wells' theory of the natural formation of dew, and since his time the one universally received, is that it results from a reduction of temperature taking place in the bodies upon which the dew forms, by which they become colder, to a sufficient extent, than the atmosphere around them. Previous to the publication of this theory, the coldness of bodies on which dew was formed was held to be an *effect* of the dew instead of its *cause*. The reduction of temperature which causes the dew is the consequence of the radiation of heat from bodies. Dew is *formed at* (and not let fall upon) the surface of bodies, from the aqueous vapours in the atmosphere "in a pellucid state." This occurs when the air is cooled, by contact with the cold bodies, to that point at which the moisture in the air is sufficient to charge it to repletion.

This theory explains, among other observed facts, why different quantities of dew are formed upon bodies of the same kind in different situations; why dew forms on clear nights, and not on cloudy nights; why the same degree of cold in a body may be attended with the formation of much, little, or no dew; why dew forms on some substances more than on others; why dew and frost (frozen dew) deposits on the projecting parts of bodies more than on the massive parts; and, indeed, why all the varied phenomena of the formation of dew and frost occur as they do.

* "An Essay on Dew, and several Appearances connected with it." By William Charles Wells. Edited, with Annotations, by L. P. Casella, F.R.A.S.; and an Appendix by R. Strachan, F.M.S. London: Longmans. 1866.

Mr. Casella's notes are very appropriate, and serve, with the matter in the Appendix, to bring the essay fully down to the present state of knowledge on the subject. This Appendix, by Mr. Strachan, is formed of articles on the Action of Aqueous Vapour on Radiant Heat, on Solar Radiation, on Terrestrial Radiation, and on the Spectrum of Aqueous Vapour. The publishers have also issued the work in a handsome form, so that everything about it leads us to anticipate for it a rapid sale.

MAUNDER'S TREASURY OF SCIENCE.*

THE present edition of Maunder's Scientific Treasury has been thoroughly revised, and in great part rewritten, and has upwards of a thousand new articles added. As a Literary Treasury it has not much to recommend it, the literary articles being very few and far between. As a Scientific Treasury it is exceedingly good, and the editor, Mr. Yates Johnson, has, with considerable success, carried out his attempt to impart to the work an exact and scientific character, without diminishing its utility as a dictionary for popular reference.

CONIC SECTIONS.†

THIS is a small treatise extending over only eighty or ninety pages, intended by the author as a first course of lessons and exercises, to prepare the young student for reading the treatises of Salmon, Hymes, Puckle, and Todhunter. Treating only of the equations of the straight line, circle, and the other conic sections referred to rectangular co-ordinates, and of elementary problems upon their curves, it is certainly simpler for acquisition than are the works which discuss the subject more comprehensively. It puts off, in fact, many of the difficulties of the subject for mastery by the student at a future day by means of other instruction. All that it contains appears to be plainly stated, and ought to be intelligible to students of ordinary capacity, though we are not satisfied that it possesses in this respect any marked advantage over the treatises of Puckle and Young. It has full claim to its title of "An Easy Introduction to Conic Sections."

* "The Scientific and Literary Treasury." By Samuel Maunder. New Edition, by James Yates Johnson, Cor. M.Z.S. London: Longmans & Co. 1866.

† "An Easy Introduction to the Higher Treatises on the Conic Sections." By the Rev. John Hunter, M.A. London: Longmans, 1866.

SCIENTIFIC SUMMARY.

AGRICULTURE.

THE *Accumulation of the Nitrogen of Manures in Soils*.—A paper on this extremely important subject has been prepared by Messrs. Lawes and Gilbert, in which the authors have described the various conditions favourable and unfavourable to the retention of nitrogen by the soil. The more striking general result of these researches was that, although a considerable amount of the nitrogen of the supplied manure which had not been recovered as increase of crop was shown to remain in the soil, still a larger amount was as yet unaccounted for. Initiative results indicated that some existed as nitric acid in the soil, but it was believed that the amount so existing would prove to be but small. In fact, it was concluded that a considerably larger portion would remain entirely unaccounted for in the soil than was there traceable, and the probability was that at any rate much of this had passed off into the drains, or into the lower strata of the soil. Finally, it was shown, by reference to field results, that there was not more than one or two bushels of increase in the wheat crop per acre per annum due to the large accumulated residue of nitrogen in the soil, notwithstanding its amount was many times greater than that which would yield an increase of twenty bushels or more if applied afresh to soil otherwise in the same condition. On the other hand, it was shown that the effect of an accumulated residue of certain mineral constituents was not only very considerable in degree but very lasting.

Effects of Irrigation with Development of Certain Plants.—In a series of papers in the *Artizan* on the effects of irrigation on plants, the following statements are made, and deserve attention. It is said that a marked effect of liberal sewage irrigation on the mixed herbage of grass land is greatly to develop the grasses, to diminish the Leguminosæ, and to reduce the prevalence of miscellaneous or weedy plants, but much to encourage individual species. Among the grasses, according to locality or other circumstances, the rough meadow-grass (*Poa trivialis*), couch-grass (*Triticum repens*), rough cock's foot (*Dactylus glomerata*), woolly soft grass (*Holcus lanatus*), and perennial rye-grass (*Lolium perenne*) have been observed to become very prominent; two or three only remaining in any considerable proportion after some years of liberal sewage application. But sewaged produce being generally cut or grazed comparatively young, the tendency which the great luxuriance of a few very free-growing grasses has to give a coarse and stemmy later growth is not an objection, as in the case of meadows left for hay.—Vide *The Artizan*, October, November, December, 1866.

ASTRONOMY.

At last we have seen a real star-shower! The scene described with such force by Humboldt in his *Personal Narrative* has been made intelligible to us, although at the same time it is clear that the recent display was, after all, only a mere indication of the brilliancy of those of 1799 and 1833. Still we have seen enough to validate the theory of Olmsted, to endorse the admirable investigation of Newton, and to disconnect for ever meteors from Meteorology. From this point of view it is extremely satisfactory to learn that the Royal Astronomical Society have taken steps to obtain a complete discussion of the observations as soon as possible. The world has been so meteor-mad lately that it will hardly brook the delay that must take place before the Luminous Meteor Committee of the British Association make their report at the next meeting at Dundee.

The December meeting of the Royal Astronomical Society was taken up entirely with what we may look upon as a preliminary investigation. Two very important facts came out. The first was that the spectroscopic observations were without result; the second, that Professor Adams, from his own observations this year, has arrived at almost the same conclusions as Newton, whose data were derived from the records of previous showers, commencing A.D. 902, the account in that year running as follows:—"In the year 599 (A.H.) on the last day of Muharram, stars shot hither and thither, and flew one against another, like a swarm of locusts; this phenomenon lasted until day-break; people were thrown into consternation, and made importunate supplications to God the Most High; there was never the like seen except on the coming out of the Messenger of God—on whom be benediction and peace."

Let us briefly, in the first instance, state the theory. It is now known that the bodies, which, when they enter our atmosphere, give rise to the appearances of falling stars and meteors, are so numerous that there are 13,000 of them in each part of space as large as our earth; and that, could all which enter our atmosphere in a period of twenty-four hours—including those visible in a powerful telescope—be counted, they would number not less than 400,000,000. There is ground for supposing, however, that in the main these little bodies are congregated into rings, each particle of the ring revolving like a planet round the sun.

The November ring is so situated in space that it cuts our orbit at the point occupied by our planet on November 14. This is the *descending node* of the ring. Where the other node lies, we do not exactly know; we only know that it does not cut our orbit; if it did, another star-shower would occur in May. We have, however, possibly another kind of proof of the existence of the node, not far within our orbit, in the almost constant retrogression of the temperature about May 12, which has been ascribed to the bodies composing the ring cutting off the sun's heat from us.

Similarly, one of the nodes of the August ring is situated in the point of the earth's orbit occupied by our planet on August 10. The November ring, according to Newton, is inclined to the plane of the ecliptic, at an angle of 17° or 19°; the August one at an angle of 79° or so.

Now, the fact that the early records state the shower to have occurred in

October places the cosmical nature of the ring beyond all doubt. It proves, in fact, that the meteors are independent of the *precession of the equinoxes*.

As this ring crosses our orbit in a certain definite point in space, our earth will always traverse it when it occupies the same definite point of its orbit with regard to the stars. Our ordinary year, however—the tropical year—being affected by the precession of the equinoxes (as it is measured from equinox to equinox), we do not measure it by the stars, but by an empirical point called the first point of the sign *Aries*, which is actually at the present moment in the constellation *Pisces*. If we refer the recorded star-showers to the sidereal year, we find an almost absolute identity in the dates of their appearance.

The ring is not of uniform density throughout, but in one part of it there is a clustering together of the little bodies of which it is composed—a few stragglers being scattered along the rest of its circuit. According to Newton, the meteors, which revolve round the sun in a direction opposed to the earth's motion, complete their circuit most probably in 354·621 days—our own being accomplished in 365·256 days. This is the same as saying that the annual motion of the group is $1 + \frac{1}{33\frac{1}{2}} \frac{1}{25}$ revolutions; consequently, the densest portion of the ring is brought into contact with the earth once in every 133 years, but the earth passes very near this portion four times in this interval.

Now, given our earth in its orbit cutting such a ring as we have described, what must happen? It will be necessary to enquire into this somewhat closely to understand the modification which possibly may result from this year's observations.

In the first place, the longitude of the spot from which the meteors appear to proceed will be 90° behind the sun, as that is the spot towards which the earth is progressing in longitude at any moment, supposing the orbit circular. Secondly, as the place of a star is subject to variations, owing to the motion of the earth in its orbit, and the progressive motion of light, so does the latitude of the radiant from which the meteoric bodies appear to proceed depend upon their velocity, compared to that of the earth. Thus Newton, assuming that the velocity of the meteors was equal to that of the earth, but in a contrary direction, argued an inclination of 17° from a radiant point, with a latitude of 8° 30'. Professor Adams, we believe, already sees reason to doubt the exactness of the period determined by Newton, and the latitude of the radiant this year appears to have been somewhat greater than that determined from the prior observations. But, as Professor Adams has shown, the fact that the longitude agrees with what Mr. Pritchard has aptly termed the *apex of the earth's way* is beyond all question, when we take the elliptic form of our orbit into consideration, as the difference between them lies within the errors of observation, and, moreover, a correction must also be applied for the position of the observer with regard to the position of the earth's centre and the direction of its motion.

There seems a little doubt as to whether there was not more than one radiant point in the last display. The principal one is *Leo*—the exact point in longitude towards which the earth was journeying at the time was very marked.

Among all the meteors seen by the present writer, from 11 P.M. on Tuesday till 2 A.M. on Wednesday morning, *two only* were decided exceptions to the general direction. At the radiant point itself, it was a subject of general remark, the meteors appeared trainless, and shone out for a moment like so many stars, because they were directly approaching us; near this spot they were so numerous, and all so foreshortened, and for the most part faint, that the sky at times put on almost a phosphorescent appearance. As the eye travelled from this region, the trains became longer, those being longest as a rule which first made their appearance overhead, or which tended westward. There were moments in which the meteors belted the sky like the meridians on a terrestrial globe, the pole of the globe being represented by the radiant point.

It is to be hoped, now the full significance of the radiant has come out, that we may soon have a complete discussion of all the radiant points hitherto determined, and their relationship with the direction of the earth's motion.

So much for one part of the theory. The Astronomer Royal has called attention to the meaning of the *lulls* in the display; we have here possibly a means of determining the shape of the meteoric ring through which we passed. It will be seen from the following table that these lulls were but subsidiary to a well-marked rise and fall:—

	h.	h.		No. of Meteors.
Tuesday night, between	9	and 10	.	10
Nov. 13.	9	— 11	.	15
	11	— 12	.	168
Wednesday morning,	12	— 1	.	2032
Nov. 14.	1	— 2	.	4860
	2	— 3	.	832
	3	— 4	.	528
	4	— 5	.	40

From 9 to 10.30 the rate of fall was one per minute; at 12 the numbers increased, and rose at 12.10 to 20 a minute; twenty minutes afterwards the number was 37; then after thirty minutes, 70; then 47 a minute for the next ten minutes; and then a rise to 90 a minute. The total number recorded was 8,485, and the time of maximum was between 1 and 2.

That the ring is thin seems to follow from the fact that the maximum display was seen at Malta pretty much at the same time as with us, and that the shower had entirely ceased by the time the radiant point had risen in America.

It is not necessary on the present occasion to refer more particularly to the various observations made; we trust soon to be in a position to give a summary of all the facts new to science gained from them.

We now come to the Sun. Messrs. De La Rue, Stewart, & Loewy have published the Second Series of their "Researches on Solar Physics," giving the area-measurements of the sun-spots observed by Carrington during the seven years from 1854-1860 inclusive, and deductions therefrom.

The authors began by establishing the trustworthiness of Carrington's sun-pictures, and then measured for each group the amount of spotted area, inasmuch as the method hitherto employed, namely, the mere statement of the number of sun-spots occurring at any period, can only be supposed to afford very approximate means of estimating the extent of solar activity at that period; while, again, if we wish to study the behaviour with respect to size of each group as it passes over the visible disk, this can only be done accurately by the laborious but sure method of measurement.

One of the enquiries has reference to the relative distribution of spotted area over different parts of the solar disk. The word *disk* is used in contradistinction to *surface*, because it is evident that, on account of the sun's rotation, the centre of his visible disk on one day does not represent the same portion of the solar surface as on another day; indeed from this cause it is well known that sun-spots travel over the visible disk from left to right. It is therefore *one* enquiry to study from day to day the relative distribution of spotted area over different parts of the sun's actual surface, and *another* to study the same from day to day over different parts of his apparent disk.

It follows from the investigations—for details of which we must refer to the paper itself—that, *in the first place*, during the time embraced in a series, the amount of spotted area which crosses one ecliptical longitude is different from that which crosses another—that is to say, the average size of a spot varies with the ecliptical longitude.

In the second place, there seems to be a periodical recurrence of the same sort of behaviour, the period of recurrence of the same behaviour appearing to be nineteen or twenty months.

In the third place, in all these recurrences the progress of the maximum is from left to right, *not* right to left. The authors continue:—

"We cannot see that these phenomena can possibly be explained unless it be admitted that the behaviour of sun-spots is subject to some external influence, the nature of which will best be determined by the order of recurrence and length of period of the phenomena in question.

"In the first place, it is clear that the influence is not stationary, otherwise its period would be one year, that being the time in which the earth (which must be regarded as the standpoint from which these phenomena are viewed) accomplishes one revolution round the sun. Again, since the march of the phenomena is from the left to the right of the earth, this would seem to identify the influence with one of the inferior planets which passes over the sun's disk in this direction, the superior planets going the opposite way.

"The period of twenty months will now enable us to determine which of the inferior planets exercises the predominant influence on sun-spots. We have to ask which of the two inferior planets takes twenty months to return to the same position with respect to the earth. This evidently points to Venus, for which the synodical period is 583 days, or between nineteen and twenty months. We may remark that, apart from all observation, if we suppose the various planets to affect the behaviour of sun-spots, the influence of Venus should be very great, on account of its nearness to the sun combined with its very considerable size. . . . The average size of a spot

would appear to attain its maximum on that side of the sun which is turned away from Venus, and to have its minimum in the neighbourhood of this planet."

In reply to the question, Does not Jupiter appear to exert any influence? as, although its distance is much greater than that of Venus, yet its mass is very great, it is shown that the influence of Jupiter is really great, although not apparently predominating.

Not only have we these effects in longitude, but it would appear that spots are nearest to the solar equator when the heliographical latitude of Venus is 0° , and are most distant from the solar equator when this planet attains its greatest heliographical latitude.

The concluding remarks of the authors are as follows:—

"The following question may occur to our readers, How is it possible that a planet so far from the sun as Venus or Jupiter can cause mechanical changes so vast as those which sun-spots exhibit? We would reply in the following terms to this objection :

"We do not, of course, imagine that we have as yet determined the nature of the influence exerted by these planets on the sun; but we would, nevertheless, refer to an opinion expressed by Professor Tait, 'that the properties of a body, especially those with respect to heat and light, may be influenced by the neighbourhood of a large body.' Now, an influence of this kind would naturally be most powerful upon a body such as the sun, which possesses a very high temperature, just as a poker thrust into a hot furnace will create a greater disturbance of the heat than if thrust into a chamber very little hotter than itself. In the next place, it is not to be inferred that the mechanical equivalent of the energy exhibited in sun-spots is derived from the influencing planet any more than it is to be inferred that the energy of a cannon-ball is derived from the force with which the trigger is pulled.*

"The molecular state of the sun, just as that of the cannon or of fulminating powder, may be extremely sensitive to impressions from without; indeed we have independent grounds for supposing that such is the case. We may infer from certain experiments, especially those of Cagniard de Latour, that at a very high temperature and under a very great pressure the latent heat of vaporisation is very small, so that a comparatively small increment of heat will cause a considerable mass of liquid to assume the gaseous form, and *vice versa*. We may thus very well suppose that an extremely small withdrawal of heat from the sun might cause a copious condensation; and this change of molecular state would, of course, by means of altered reflection, &c., alter to a considerable extent the distribution over the various particles of the sun's surface of an enormous quantity of heat, and great mechanical changes might very easily result.

"Again, although we cannot suppose our earth to be nearly so sensitive as the sun, yet the question may be entertained, Does the moon exert an influence of this kind upon the earth?"

It is not a little curious that since the authors' preliminary research into

* It is, however, a possible enquiry whether these phenomena do not imply a certain loss of motion in the influencing planets.

the behaviour of sun-spots, a suggestion of the illustrious Galileo, which he appears not to have published from want of evidence, has been brought to light by the Rev. William Selwyn. This suggestion advocates a method of research allied to that in which the Kew astronomers are now engaged.

Spectroscopic Observations of the Sun is the title of a paper recently presented to the Royal Society by Mr. J. Norman Lockyer. The author remarks that the two most recent theories dealing with the physical constitution of the sun are due to M. Faye and to Messrs. De la Rue, Balfour Stewart, and Loewy. The chief point of difference in these two theories is the explanation given by each of the phenomena of sun-spots. Thus, according to M. Faye, the interior of the sun is a nebulous gaseous mass of feeble radiating-power, at a temperature of dissociation; the photosphere is, on the other hand, of a high radiating-power, and at a temperature sufficiently low to permit of chemical action. In a sun-spot we see the interior nebulous mass through an opening in the photosphere, caused by an upward current, and the sun-spot is black, by reason of the feeble radiating-power of the nebulous mass. In the theory held by Messrs. De la Rue, Stewart, and Loewy, the appearances connected with sun-spots are referred to the effects, cooling and absorptive, of an inrush, or descending current, of the sun's atmosphere, who is known to be colder than the photosphere.

In June 1865 the author communicated to the Royal Astronomical Society some observations which had led him independently to the latter conclusion. The observations indicated that, instead of a spot being caused by an *upward* current, it is caused by a *downward* one, and that the results, or, at all events, the concomitants, of the downward current are a dimming and possible vaporisation of the cloud-masses carried down.

On March 4 of the present year a spectroscopic observation of sun-spots was commenced, with a view of endeavouring to test the two rival theories, and especially of following up the observations before alluded to.

On turning the telescope and spectrum-apparatus, driven by clockwork, on to the sun at the date mentioned, the solar spectrum was observed in the field of view of the spectroscope with its central portion (corresponding to the diameter of the umbra falling on the slit) greatly enfeebled in brilliancy. All the absorption-bands, however, visible in the spectrum of the photosphere, above and below, were visible in the spectrum of the spot; they, moreover, appeared thicker where they crossed the spot-spectrum.

Mr. Lockyer was unable to detect the slightest indication of any bright bands.

Should these observations be confirmed by observations of a larger spot free from "cloudy stratum," it will follow, not only that the phenomena presented by a sun-spot are not due to radiation from such a source as that imagined by M. Faye, but that we have in this absorption-hypothesis a complete or partial solution of the problem which has withstood so many attacks.

The paper concludes as follows: "Seeing that spectrum-analysis has already been applied to the stars with such success, it is not too much to think that an attentive and *detailed* spectroscopic examination of the sun's surface may bring us much knowledge bearing on the physical constitution of that luminary. For instance, if the theory of absorption be true, we may

The foreign journals have been remarkably destitute of astronomical news lately. This is fortunate, as our summary already exceeds its ordinary limit.

BOTANY.

The "Cybele Hibernica."—The invaluable work which Mr. Watson achieved for England is being imitated on the other side of the Irish Channel. Messrs. Moore and More have issued a volume upon the subject of the distribution of Irish plants, and the facts it lays before the Botanical public are both numerous and interesting. Taking the number of species for Britain proper at Mr. Watson's estimate of 1,425 species, the authors of the "*Cybele Hibernica*" claim for Ireland about 1,000 species. Of the 532 plants of the British type, Ireland has all, or very nearly so. The Atlantic type is the only other one where she has decidedly more than half, forty-one species out of seventy. Of the Boreal species (Highland, Scottish, and intermediate types taken together), although there is not a single one of the twelve provinces in which there is not a hill of upwards of 2,000 feet in altitude, Ireland has only 106 species out of 238. Of the 458 English and local species she has just over one-half; and, finally, out of the 127 Germanic species only 18.

Doubtful species being left out, the number of species ascertained in Ireland, but not known in Britain proper, is reduced to twelve. Only five of these—*Saxifraga Geum*, *Erica mediterranea*, *Arbutus Unedo*, *Dabaecia polyfolia*, and *Neotinea intacta*—are for Europe as a whole specially south-western in their distribution; whilst three—*Sisyrinchium anceps*, *Neottia gemmipara*, *Naias flexilis*,—are North American plants not known on the European continent.—Vide *The Journal of Botany*, October.

The Flora of the Fiji Islands.—The fifth part of this fine work by Dr. Seemann has just been published; this, we learn, completes the *Monopetalous* and *Polypetalous* orders.

The Cedars of Lebanon.—A very interesting communication relating to the far-famed "cedar of Lebanon" has been recently made to the *Gardener's Chronicle* by Dr. J. D. Hooker. Dr. Hooker states that he has been informed by the Rev. M. Tristram that an American missionary, Mr. Jessup, has discovered several new groves of cedar-trees. Of these there are five, three of great extent, east of 'Ain Zabalteh, in the Southern Lebanon. This grove lately contained 10,000 trees, and had been purchased by a barbarous sheikh from the more barbarous Turkish government for the purpose of trying to extract pitch from the wood; the experiment failed; the sheikh was ruined, but the result was the destruction of several thousand trees. One of the trees measured fifteen feet in diameter, and the forest is full of young trees, springing up with great vigour. He also found two small groves on the eastern slope of Lebanon, overlooking the Buka'a, above El Medefuk; and two other large groves, containing many thousand trees, one above El Baruk, and another near Ma'asiv, where the trees are very large and equal to any others; all are being destroyed for firewood. Still another grove has been

discovered near Dâma, in the western slope of Lebanon, near to the one discovered by Mr. Tristram himself.

The Newfoundland Heather.—About a year ago we pointed out in our *Summary* that the *Calluna vulgaris*, or common British heather, had been said to have been found growing in North America. Some interest attaches to the subject, and therefore we are glad to direct the attention of our readers to a paper by Dr. Seemann in the *Journal of Botany* (No. xlv.) upon a comparison between the American and the British species. Dr. Seemann observes that Dr. Moore, of Dublin, who cultivates the two varieties side by side, noticed that, “whilst the Newfoundland one always suffered from frost, and turned brown during the mild Irish winter, the common British form growing by its side was unaffected by cold, and preserved its usual green colour.” Dr. Seemann states that, though at first sight the plants seem to be as different as possible from each other, there is nevertheless considerable difficulty in indicating the structural differences between the two. Dr. Seemann gives the following as the chief points of difference between the British and American specimens. The leaves of the Newfoundland plant are always closely adpressed to the stem; those of *Calluna vulgaris* are generally patent; the pedicels of the Newfoundland plant are always naked; those of the true *C. vulgaris* are, especially those of the lowest flowers, foliaceous, so that they form little branchlets, terminating in a solitary flower; whilst the sepals and petals of the Newfoundland plant are ovate and inflexed, those of the common British heather are rather oblong and not inflexed. Again, in the Newfoundland plant the tip of the flowering branches does not put forth fresh shoots whilst the flowering lasts; but in the common British heather a fresh shoot issues when the flowering is at its height.

The History of the Potato.—In a paper lately read by Mr. Crawford, on “The Relation of Plants to Ethnology,” a very short but complete account was given of the introduction of the potato into Europe. The potato is still found on the western slopes of the Andes, the tubers, however, being no bigger than the common filbert. Even the Indians, said Mr. Crawford, cultivated the potato before the arrival of the Europeans. It was first brought from America to Ireland, where it was cultivated in 1586; but it is said to have been introduced into Spain and Portugal even before this date. From Ireland it found its way to the Low Countries and to Germany, and from Spain it reached Italy and France. It is an object of cultivation in Asiatic countries only where Europeans have colonised or settled, and there chiefly for their consumption, and only since the beginning of the present century. It is successfully cultivated in Australia and New Zealand, which produced no esculent farinaceous root at all, not even the yam, the taro, or the manioc.

Functions of the Stomata of Leaves.—The ordinary theory that the stomata of leaves are the breathing-organs through which the carbonic acid is decomposed has met with two new opponents in M^r. Duchartre and Boussingault. These observers allege that the quantity of carbonic acid decomposed by the leaves of plants has no relation to the number or superficial extent of the stomata. They further state that in the case of fruits the green parts decompose carbonic acid, and yet contain no trace of stomata.

The Starchy Matter of Plants.—A paper, laid quite recently before the French Academy by M. Arthur Gris, states as a conclusion that the amyloseous matter contained in plants is partly resorbed during the development of the flowers, but that this process is not continued during the development of the fruit.

The Fecundation of the Floridææ.—There are few subjects of higher interest to the student of vegetable physiology than that of the mode of reproduction of plants. The processes which occur among the Algæ generally have been of late years very clearly made out; but it would seem, from a memoir published by MM. Bornet and Thuret, that the fecundation of some of the Algæ is different from what is generally thought to be the process. These authors have written a very long paper, describing the structure and functions of the antherozoids, &c. of the Floridææ, and have given a number of details which we cannot lay before our readers. Their general conclusion, however, shows the view they take, and is as follows:—"It appears from the preceding observations that the phenomena of fecundation in the Floridææ are very different from those which occur in the other Algæ. The structure of the organs, their mode of action, the period when their functions are discharged, and the effects which they produce, distinguish them from the other Algæ. There is no direct action of the antherozoids on the reproductive bodies in these plants. The operation is less simple, and in some respects resembles that which occurs in the higher plants. Here we find fecundation produced by motionless corpuscles on an external organ, the result of which is the complete development of the organ of fructification."—Vide *Comptes Rendus*, Sept. 24.

Chinese Soap Seeds.—M. Payen, in a memoir on the Leguminosæ, whose seeds are used as soap by the Chinese, has supplied botanists with the following interesting facts: These seeds are of two species, which differ slightly in chemical and microscopical characters. The first series, which has been more extensively examined than the other, is considered by M. Decaisne to belong to the genus *Dyallum*. In the seed one finds, first, a stratum of about two or three millimetres thick, composed of cells, containing grains of starch, a substance analogous to saponine, and a nitrogenous oil. Within this envelope is the embryo, surrounded by a compact perisperm, whose structure and composition are quite peculiar. In this M. Payen has found cells with thin walls, containing grains of starch, coloured yellow by iodine, and contracted by sulphuric acid, and a special amorphous secretion, which absorbs thirty times its weight of water. This absorption gives rise to a sort of jelly, which, when separated, precipitated by alcohol, and evaporated to dryness, gives colourless tablets, like layers of gelatine. This, says M. Payen, is not to be confounded with pectine and bodies of the pectine group. It is allied to cellulose, but is not coloured blue by iodine. M. Payen proposes to term it *Dyallose*.—Vide *L'Institut*, No. 1767.

Deceased Botanists.—We regret to have to record the deaths of two most distinguished continental botanists, Dr. Kotschy, of Vienna, and Dr. Mettenius, of Leipzig. The former was for some time assistant in the Vienna Herbarium, and was author of several books of travel and of a monograph on Oaks. Dr. Mettenius was Professor of Botany and director of the Botanic Garden at Leipzig.

The Diagnosis of the Alga.—Upon this subject a controversy has been going on for some time past between Mr. Archer, of the Dublin Natural History Society, and Dr. Braxton Hicks, F.R.S. The latter contends that there are so many intermediate forms between the earlier and later stages of the development of certain plants, which are in every respect like what Mr. Archer considers adult forms, that diagnosis from the examination of specimens alone not undergoing development is unsatisfactory. Dr. Hicks asks how Mr. Archer can say whether a specimen is a fixed form, a separate entity, or merely a transitorial form of some other growth. To this Mr. Archer replies that the mere fact of conjugation taking place is sufficient to prove the adult nature of the species under examination. Dr. Hicks, we believe, does not look on conjugation as a true generative act.—*Vide Quarterly Journal of the Microscopical Science*, October.

CHEMISTRY.

Action of Magnesium on Neutral Metallic Salts.—In a paper read before the French Academy, on October 1, M. A. Commaille states that hydrogen is always evolved when a metal is precipitated by magnesium, and in such cases the precipitation is incomplete. In the case of sulphate of iron, hydrated protoxide of iron is thrown down; in an acid solution, metallic iron is precipitated. With mixed chromic and chromous chloride, hydrated sesquioxide of chromium is precipitated. With manganous sulphate, the reaction is the same as with iron. With cobalt sulphate, the reaction is very slow; after a few days the hydrated oxide, Co_2O_3 , deposits on the magnesium. With nickel sulphate, the precipitate formed is the hydrated protoxide. With oxalate of uranium, a golden-coloured deposit of hydrated sesquioxide is produced— $\text{U}_2\text{O}_3 \cdot \text{HO}$. With sulphate of zinc, there is an energetic action, and the metal, the hydrated oxide, and sub-sulphate are precipitated. With chloride of cadmium, the reaction is also very energetic, and a mixture of oxychloride of cadmium, and metallic cadmium, is precipitated. Bismuth salts being acid give a precipitate of pure metallic bismuth. Protochloride of tin gives spongy tin and stannic acid. The disengagement of gas is very strong with neutral chloride of lead; the deposit consists of lead mixed with oxychloride.

Magnesium Rods for Toxicological Purposes.—The *Chemical News* states that some of Mr. Mellor's magnesium rods which have been examined by the editor have been found to answer their purpose exceedingly well. They are intended to replace zinc in the detection of arsenic and other poisonous metals. When examined in connection with Marsh's apparatus, they gave no indication of deposit which could be confounded by the chemist with arsenic, &c.

Preparation of Pure Caustic Alkalies.—A method by which the carbonates may be rendered so pure that they only exhibit traces of chloride has been discovered by M. Graeger. This chemist first treats them with carbonate of silver, and then boils them with lime from calcined marble. The ley is then filtered through a funnel, in the bottom of which are placed

fragments of marble and powdered marble, first pouring distilled water through till it passes perfectly limpid.—*Journal für praktische Chemie.*

Organic Matter in Water.—As it has been proposed to obtain the future water-supply of London from the English lakes, it is of interest to compare (as has been done by the *Chemical News*) the analysis of the water of the lakes with that of the London waterworks. According to Mr. Way, the grains of organic matter per gallon is in—

River Lowther	0.62
Haweswater	0.62
Ulleswater	0.35
Thirlmere	0.77

giving an average of 0.59 grains.

According to Dr. Letheby, the organic matter per gallon is in the—

Grand Junction Waterworks	0.60
West Middlesex	0.48
Southwark and Vauxhall	0.64
Chelsea	0.53
Kent	0.03
New River	0.22
East London	0.56

showing an average of 0.44 grains; or a balance against Cumberland of 0.15 grains of organic matter per gallon.—*Vide Chemical News*, November.

A Crystalline Fatty Matter in Urine.—At a recent meeting of the Royal Society, Mr. Edward Schunck read a paper with the above title. Mr. Schunck says that the occurrence of fatty matter in urine is a somewhat rare phenomenon, and is generally considered as a symptom of disease. In most of the instances that have come under his notice, it was found associated with albumen in which the fatty particles were embedded; more frequently, however, it is found enclosed in cells so heavy as to sink to the bottom of the vessel. Mr. Schunck gives the following method for the extraction of the peculiar brown-yellow oil which he described. Healthy urine is filtered through animal charcoal, till the percolating liquid ceases to be decolorised, and begins to pass with extreme slowness. It will be found that a very small quantity of charcoal will decolorise a very large portion of the liquid. The charcoal is then well washed with water to dissolve the soluble salts, dried, and afterwards treated with boiling alcohol, to which it communicates a bright-yellow colour. The liquid must then be filtered, evaporated, and the brown syrup residue mixed with water, which deposits a brown semifluid fatty matter, which can be separated by filtration.

On Blue Litmus Paper as a Test for Acidity.—In the course of a recent discussion at the French Academy, on the subject of silkworm disease, M. Chevreul made some interesting observations on the above subject. It appears that the most delicate blue paper owes its colour to the red principle of litmus united with subcarbonate of potash; and when a body reddens this, it only signifies that the substance has more affinity for potash than the red colouring matter of litmus has. But in the preparation of ordinary blue litmus paper, instead of using paper free from mineral matter,

the makers use paper containing subcarbonate of lime, sesquioxide of iron, &c. Now subcarbonate of lime also colours litmus blue, and this compound gives up its base to acids with much greater difficulty than the blue potash-compound does. Therefore, in order to prepare the most delicate blue litmus-paper, the latter should be first soaked in hydrochloric acid, and then well washed, before applying the litmus. Ordinary red litmus-paper is much more sensitive to alkaline reaction than blue paper is to acid. M. Chevreul said that the most delicate means to detect acidity was to put a freshly-cut piece of campeachy-wood into distilled water. If free from alkali, the colour will be yellow, but if there is a trace of alkali present, the tint is purple; then add a minute quantity of acetic acid on the point of a quill, when the colour will turn yellow. This liquid becomes purple with a trace of alkali, and acids change the purple to yellow.

Analysis of the Waters of Perg  . By M. A. B  champ.—We learn from our contemporary, the *Chemical News*, that M. B  champ has discovered in these waters considerable quantities of acetic and butyric acids. This is the first time that organic acids have been found in a French spring. Upon examining the deposit of this water under the microscope, a considerable number of mobile corpuscles were observed, similar to those seen in native chalk. M. B  champ supposes that these are the causes of the formation of the volatile fatty acids.

The Compounds of Niobium.—M. Marignac, in a recent memoir, endeavours to disprove the existence of ilmenium. He believes that the niobic acid extracted from columbite is not a mixture; that its density is about 4.5; and that the two products, obtained by M. Hermann, having densities of 5 and 3.8, are mixtures of this acid with bodies of a greater and less density, chiefly tantallic and titanlic acids.

Detection of Free Sulphuric Acid in Acetic Acid.—The following simple process for this purpose is given in *Boettger's Polytechnisches Notizblatt*: Boil about fifty cubic centimetres of the acid to be tested in a retort with a very small quantity of starch, until half the liquid is distilled; after it has cooled, add a drop of tincture of iodine. If, under these circumstances, a blue coloration be produced, no sulphuric acid is present. If the blue colour does not appear, it may be concluded that sulphuric acid is present, which, by reacting on the starch, will have transformed it to glucose. With tincture of iodine, glucose gives no particular coloration. Sulphuric acid, thus detected, may be estimated by the ordinary processes.

A New Form of Gunpowder.—This peculiar compound, the invention of Herr G. A. Neumeyer, is said to possess the following properties:—

1. The powder burns, but does not explode, if the air has access.
2. Neither pressure nor percussion will cause it to ignite.
3. Its explosive force is equal to that of ordinary powder or even greater.
4. It leaves behind less residue than ordinary powder.
5. It does not attract more moisture from the atmosphere than ordinary powder.
6. It leaves behind less powder-smoke than ordinary powder. Its smoke, moreover, is light, disappears quickly, and has no injurious effect on the health of the workmen.

7. It is cheaper than ordinary powder in the proportion of 30 to 31. The prices by weight are the same, but as it has been found that 76½ grains of Neumeyer's have the same explosive force as 79½ grains of ordinary powder, the above proportion may easily be deduced.—Vide *Berg- und hüttenmännische Zeitung*, No. 36, 1866.

The Synthesis of Resorcine.—Herr Korner has been engaged in some researches upon resorcine. To those who have waged war against chemical technicalities, the following paragraph may be of interest. Herr Korner starts with benzol; converts this into binitrobenzol; from this prepares paranitroaniline; transforms the nitrate of this base into nitrate and then sulphate of paradiazonitrobenzol. Under the influence of hydriodic acid this salt gives paraiodonitrobenzol, which, with tin and hydrochloric acid, is reduced to paraiodaniline. From the nitrate of this base the sulphate of paradiazoiodobenzol is formed. This salt decomposed by boiling water gives a new acid, paraiodophenic acid. This is solid and well crystallised; its most remarkable property is to give, under the influence of fused potash, a crystallised combination which is the inferior homologue of orcine described by M.M. Hlasiwicz and Barth under the name of resorcine. Herr Korner hopes to show that phloroglucine and pyrogallie acids are trihydroxylic derivatives of benzol, and that, by starting from toluol, he will effect the synthesis of orcine.

The Detection of Iodine.—Mr. Carey Lea, the celebrated American photographer, has suggested a new and useful test for the presence of iodine. It states that, while engaged in testing for iodine, it occurred to Mr. Lea that the facility with which that body is eliminated from its hydrogen and metallic combinations by chromic acid would make the latter substance a valuable means of bringing about the starch reaction, and a few experiments completely confirmed this view. If, for example, an extremely dilute solution of iodide of potassium, such that the addition of nitric acid and starch produces no perceptible effect, is taken, the further addition of a single drop of very dilute solution of bichromate of potash will instantly bring about the characteristic reaction. When chlorhydric acid is substituted for nitric, the effect of the bichromate is (as was to be expected) still more marked. The test has the full delicacy at least of the chlorine test, with this great advantage that an excess of the reagent does not prevent the reaction.

Wine and Wine Sickness.—The results of M. Pasteur's valuable researches on this subject may thus be summarised:—1. That the dangerous changes which occur in wine arise from causes which are mixed up with those to which fermentation is attributed. 2. That the heating of ordinary wine to the extent of 50° centigrade is sufficient to kill all microscopic vegetation, or the ferments which produce them; fermentation and all other dangers due to these causes being thus arrested or prevented. 3. The application of the amount of heat indicated does not in any way effect the flavour or the colour of wine, and assures brightness. 4. Wines which have been submitted to such temperature appear capable of being kept indefinitely in closed vessels. 5. When exposed to the air, such wines, it is true, may become affected after a certain lapse of time; but this is in consequence of the air supplying them with the living germs of those ferments which they previously lost by the action of heat.

How to Silver Glass.—Those who are familiar with Baron Liebig's investigations on the subject of glass silvering are aware of the numerous difficulties that attend the deposition of mercury amalgam upon glass; the following method which has been suggested by Herr Reichardt will interest our chemical readers. Prepare four solutions—first, 10 grammes of nitrate of silver to 100 grammes of water; second, an aqueous solution of ammonia of 0.984 density; third, 20 grammes of caustic soda and 500 grammes of water; and fourth, a solution of 25 grammes of sugar in 200 grammes of water, to which is added a cubic centimetre of nitric acid, at 36°, and let the whole boil for twenty minutes. When cold, add 50 cubic centimetres of alcohol, and as much water as will make up the total quantity to 500 cubic centimetres; then take 12 parts of the first, 8 parts of the second, and 20 parts of the third solution, add 60 parts of water, and let the mixture stand for twenty-four hours; lastly, the solution No. 4 is added when the whole becomes of a blackish tint, in consequence of the finely divided precipitate of silver which begins to fall. M. Reichardt has discovered that the deposition of the silver is greatly aided by motion, and that, when the bath is continually shaken, the deposit on the inner surface of glass vases is always satisfactory, and he recommends that in silvering plates of glass they shall be placed in evaporating dishes, or other vessels, so that the sides may give an oscillating motion to the liquid in the bath when shaken. In acting on large articles, he recommends the glass plates, or other objects, to be fixed within tubs or vats, which may then be rolled or rotated pretty rapidly.—*Journal of Society of Arts*, November 1866.

Observation on the Passage of the Spark of an Induction-Coil through Flame. By A. Kundt.—If the current of sparks of an induction-coil be passed through the luminous flame of gas or of a candle, no alteration is seen in the flame, excepting that in the path of the sparks the flame is intensely luminous, and under certain circumstances this brightly luminous path of sparks is traversed by dark cross bands. When the polar wires are suitably introduced, it appears constant and steady. Yet, if the flame is viewed in a slowly rotating mirror, or in one which is moved to and fro in the hand, this apparent constancy is found really not to exist; for, looked at in the mirror, the image does not seem constantly broadened, but the part above the spark appears alternating, like the flame of a chemical harmonicon when looked at in a rotating mirror. From the upper point of the flame to the spark, the image in the mirror appears to have serrate incisions, and at the lower point of each dark incision there is a passing spark. During this transition of an individual spark, the flame, therefore, is always extinguished above. The part below the spark is constant and steady.

On the Department of Solutions of Glauber's Salt on Reduction of Temperature.—As the physical processes in the so-called supersaturation of Glauber's salt solutions have as yet found no sufficient explanation either from physicists or chemists, it will not be uninteresting to our readers if we place before them the conclusions of Dr. F. Lindig, of Schwerin.

If a solution of Glauber's salt, whether saturated or not, is allowed to cool slowly, it contracts with diminution of temperature, like any other body, as long as there is no crystallisation. But as soon as the first crystals form in the clear solution, instead of contracting, it begins to expand, and

continues to do so in proportion as the crystallisation proceeds. Hence the density of the crystals forming is less than that of the solution from which they form. Surprising as is this deportment of a gradually crystallising solution of Glauber's salt, that of a so-called supersaturated solution is still more surprising and remarkable. If such a one by careful treatment is cooled down to 0° , and then made to crystallise suddenly, the crystal cake formed, which constitutes a compact solid mass, exhibits an extraordinary increase in volume, and on further cooling to about 10° C. below zero, contracts more and more. As in this condition of the original solution there can be no question of a separation of crystals as in the former case, it seems (like water below 4°) not to follow the law according to which bodies contract by diminution of temperature.

GEOLOGY AND PALÆONTOLOGY.

The Entire Skeleton of a Mastodon has just been discovered in a peat-bed near Troy. The jaw-bone was found near the surface. At a depth of about 50 feet the remaining bones were found. The tusks were very nearly 6 feet long and about 9 inches in diameter. One of them, upon exposure to the light, crumbled to pieces like clay, resembling that substance in appearance and texture. The ribs, of which there were 14 found, are about 4 feet long, the largest being 4 feet 9 inches. The upper jaw-bone is 4 feet 9 inches long from the extremity of the mouth to the cranium, and across the forehead measures about 3 feet. So heavy is it that it was with difficulty four labourers could move the mass. The sockets in which originally were located the eyes of the monster are almost large enough to admit the head of a man. The hip-bone is 5 feet long, and weighs 100 pounds; the shoulder-blades measure 2 feet 9 inches, and weigh about 50 pounds each. The bone of the leg at the knee-joint measures 13 inches in diameter. The vertebrae of the back-bone are 8 inches in diameter. The other fragments found are in harmonious proportion to those already mentioned.

On the Distribution of Life Rocks.—Mr. H. G. Seeley read a paper at the late meeting of the Cambridge Philosophic Society upon "The Laws Regulating the Distribution of Life of Rocks." Mr. Seeley stated that in all denudation, whether marine or subaërial and fluvial, the crystalline rocks which underwent this process were again deposited in the following order: (1) sand, (2) clay, (3) limestone; the second overlapping and appearing at the junction, to be superposed to the first, and the third to the second. Hence these deposits, which at first sight appeared to be successive, might in reality be contemporaneous. Again, deposits were commonly assumed to be contemporaneous when they contained the same fossils; but upheaval and depression would cause the fauna of any locality to move; so that remains of the same species might be deposited necessarily in different deposits. He also considered species to be re-transmutable, and to be affected by the physical conditions under which the animal was living. Therefore he maintained that strata could not be identified by these means, but by discovering the physical conditions under which they were deposited, and by other

methods. At the same meeting Mr. Seeley read a paper on the Potton Sands.—Applying these principles to the Potton Sands of Bedfordshire, he considered that the lower deposits were of the same age as the Portland sands of the South of England; the middle fossiliferous seams of the age of the Purbeck beds; and the upper deposits of the Lower Greensand.

On some Points in the Structure of Xiphosura.—At a late meeting of the Geological Society, Mr. W. Woodward, the accomplished editor of the *Geological Magazine*, read a valuable paper on the above important paleontological subject. He pointed out that Professor M'Coy's tribe, *Pecilopoda*, was intended to include the *Limuli*, with *Eurypterus*, *Pterygotus*, and *Belinurus*. Professor Huxley had already shown (in 1859) that this classification was founded upon an erroneous interpretation of the fossils, then (1849) only known in England by extremely fragmentary remains. Professor M'Coy's classification was based on conjecture rather than on a minute acquaintance with the anatomy of these extinct forms. The subsequent researches of Professors Agassiz and Hall in America, Professor Nieszkowski in Russia, and the independent investigations of Mr. J. W. Salter and the author in this country, have shown that a close relationship actually does exist between the *Xiphosura* and the *Eurypterida*. Mr. Woodward then gave a detailed comparison of the structure of these two divisions, which he proposed to call suborders of Dr. Dana's order *Merostomata*. He pointed out that the *Xiphosura* were divisible into three genera: (1) *Belinurus* [Bailly], having five freely articulated thoracic segments, and three anchylosed abdominal ones and a telson; (2) *Prestwichia*, a new genus, having the thoracic and abdominal segments anchylosed together; and (3) *Limulus* [Müller], having a head composed of seven cephalic and one thoracic segments, followed by five coalesced thoracic somites bearing branchiæ, and one or more coalesced apodal abdominal somites, to which is articulated the telson. Although so great a dissimilarity exists between *Pterygotus* and *Limulus*, yet in the genera *Hemiaspis*, *Exapinurus*, and *Pseudoniscus*, we have forms which, in the number of body-rings, are intermediate.

On the Dinosaurian Reptiles of South Africa.—Professor J. H. Huxley, in a paper he read before the Geological Society, describes a portion of a right femur $25\frac{1}{2}$ inches long, so that the entire femur may be safely assumed to have exceeded 30 inches in length. The peculiar form of the bone and the character and position of the trochanters leave no doubt of the Dinosaurian affinities of the reptile to which it belonged, which must have been comparable, in point of size, to its near allies, the *Megalosaurus* and the *Iguanodon*. To the former of these it possesses the closest affinity, but differs in the proportional size and form of its trochanters, and in its much heavier proportions; and the author proposes for it the name *Euskelosaurus Brownii*. Professor Huxley also described a portion of the distal end of a femur, indicating another genus of large-sized Dinosaurian reptiles, the characters yielded being to prove that it belongs to another genus than *Euskelosaurus*.

Secondary Fossiliferous Deposits of New South Wales.—These have been very carefully examined by the Rev. W. B. Clarke, who has recently given a description of them to the Geological Society. It appears that until the year 1860 secondary deposits were thought to be absent from Australia.

Since that date, however, secondary fossils have been discovered by various geologists. Mr. Clarke's enquiries extended over the country near the Maranoa river in Queensland, and the examination of specimens sent to him from localities between there and the Flinders river have led him to believe that there exist in that area various formations from the Triassic to the Cutaceous series. It seems that the deposits on the eastern and western sides of Australia are by no means identical.

Figures of British Fossils.—Mr. W. Hallier Baily, Palæontologist to the Irish Geological Survey, is issuing, or proposes to issue, in numbers, a series of lithographs, illustrative of characteristic fossils. The work will consist of tinted plates and explanations, but will be without letterpress. Those who are familiar with Mr. Baily's untiring industry in the pursuit of palæontology will know how to appreciate his new work. Each number will be published separately, will contain ten plates, and will be sold at the moderate price of five shillings.

Flint Cores from India.—General Twemlow has sent over from India several specimens of the above, and with them a letter to the editor of the *Geological Magazine*, asking for a notice of them. Accordingly Mr. John Evans has examined them, and has offered his opinion upon them. They present the appearance of cylinders which have a polygonal outline, and are the remnants of flints from which flint weapons have been chopped off. It seldom happens, Mr. Evans states, that a single specimen of flint is of so pure and homogeneous a character as to yield so many regular chips as those which Major-General Twemlow has sent over from the Indus. The statement of the discoverer that they were found in the bed of a river beneath three feet of rock, Mr. Evans receives with some doubt, and he considers the specimens to belong rather to what is called the *Neolithic* than the *Palæolithic* period of India.

Aculephæ in a Fossil State.—Several very well preserved fossil remains of the Medusidæ have been discovered in the lithographic slate of Eichstadt by Professor Hæckel, of Jena. The species more recently described by the German *savant* belong to the family Rhizostemidæ, the typical genus of which is so frequently illustrated in zoological text-books. Professor Hæckel's restorations seem to have been conscientiously made, and there is every reason to think that ere long the study of fossil Medusidæ may become an important branch of palæontology.—Vide *Geological Magazine*, November.

The Rocks of North Devon and Somerset.—Mr. G. J. Beete Jukes has published a paper on the grouping of these deposits. Mr. Jukes takes as his starting-point the country round Wiveliscombe, and describes the rocks of the district reaching from that place north-west to the Brendon Hills, and westward to Dulverton, including the valley of the Tone more to the south. He has arrived at the following conclusions:—(1) There are three areas of old red sandstone in this region, namely, *a*, the Quantock Hills; *b*, the Porlock, Minehead, and Dunster area; and *c*, the Morte Bay and Wiveliscombe ridge. (2) Each of these masses of old red sandstone dips under a great mass of carboniferous slate. (3) The coal-measures, the carboniferous slate, and the old red sandstone of Devon are contemporaneous with the coal-measures, carboniferous limestone, and the old red sandstone to the north of the Bristol Channel.

Madrepores of the Infra-Lias of South Wales.—In a paper read before the Geological Society, on November 21, Dr. P. Martin Duncan stated the following conclusions: (1) That the fossiliferous beds of Sutton, Southerndown, Brocastle, and Eivenny, are important members of the series which intervenes between the Trias and the beds containing *Ammonites Bucklandi*, *Gryphæa incurva*, &c. and that which has been named the *Infra-Lias*. (2) That the Mollusca and certain well-known species of Madreporana, which are grouped together at Brocastle, have similar relations to each other in the *Calcaire de Valogne*, in the zone of *Ammonites Moreanus* of the Côte d'Or, and in the Gres de Luxembourg. (3) That the above-mentioned beds in Wales, constituting a coralliferous horizon, are the equivalents of the upper beds of the French and Luxembourgian *Infra-Lias*.

Age of the Chinese Coalfields.—It will possibly surprise some of our readers to learn that the greater part of the Chinese coalfield belongs to the Mesozoic period. This has been recently demonstrated in the *American Journal of Science*; the author of the article having received several specimens of the Chinese coal-fossils, has been enabled to determine that all the carboniferous fossils are absent, and that most of the plants present are *Podozamites* and *Pterozamites*, which are essentially Cycads.

MECHANICAL SCIENCE.

H. M. S. "Waterwitch." This vessel, which has recently been tried, has been built to ascertain the value of the new system of jet propulsion, introduced by Mr. Ruthven, to which we have before adverted in these pages. The experiment is upon so large and costly a scale, and in the hands of men so thoroughly competent to carry it out, that the value of the system will doubtless be thoroughly investigated. We take the following particulars of the vessel from *Engineering*, vol. ii. p. 315 (October 28), which contains the most accurate description which has yet appeared. The "Waterwitch" was designed by Mr. E. J. Reed, and has been built by the Thames Shipbuilding Company. Her tonnage is 778 tons measurement, length 162 feet, breadth 32 feet, depth 13 feet 9 inches. She has a flat bottom, and is double-ended, each end being fitted with a rudder. She is armour-plated for a length of about 60 feet amidships, with 4½-inch plates on 10 inches of teak backing. The propelling machinery was constructed by Messrs. J. & W. Dudgeon, according to the plans of Mr. Ruthven. It consists of a set of three cylinder condensing engines, driving a centrifugal pump, by which the water is supplied to the jets, which constitute the propelling apparatus. The revolving wheel of the centrifugal pump is 14 feet in external diameter, and it has 12 arms or vanes curving upwards and outwards. From the wheel case the water is conducted through two copper pipes, which leave the case tangentially, and are led with a spiral curve to the jets at the side of the vessel. The arrangement for directing the jets either forwards or backwards consists of a large two way cock, placed at each side of the vessel just within the delivering nozzles, and by turning these cocks the water can be delivered

through either the forward or aft nozzles, or through one forward and one aft nozzle at pleasure. The delivering nozzles are of brass, 2 feet 1 inch by 1 foot 7 inches or about 452 square inches sectional area.

The engine has three cylinders $38\frac{1}{2}$ inches diameter and 3 feet 6 inches stroke.

The following results were obtained on the trial, the draught being 9 feet 9 inches and the lower edges of the jet nozzles being 8 inches below the water level.

First run. A half knot tide against the ship; speed, 8.276 knots; revolutions of engines, 41; steam pressure, 24 lbs; vacuum, 26 inches.

Second run. A half knot tide in the ship's favour; speed 9.549 knots; revolutions of engines, 42; steam pressure, 25 lbs; vacuum, 26 inches.

Mean speed = 8.912 knots.

It will thus be seen that the "Waterwitch" attained a speed sensibly identical with that of the "Viper," a twin screw, armour-plated gunboat of precisely similar tonnage, displacement, and engine power. Still the performance of the "Viper" compared with that of other vessels can hardly be considered satisfactory, and the most that can at present be assumed is that the new system of propulsion is capable of attaining results equal to the less satisfactory results with the ordinary screw propeller.

The Rev. J. A. L. Airey, M.A., has mathematically investigated the theoretical conditions of the action of the jet. His calculations show that only 18.82 per cent. of the indicated horses' power is usefully applied in the propulsion of the vessel; 18.33 per cent. is wasted in the residuary velocity of the water; and another 10 per cent. is probably consumed in engine friction, leaving 52.85 per cent. still unaccounted for.

Our own opinion is that a large part of the want of success is due to the inefficiency of the centrifugal pump, which was not of the best type, and might be most materially improved by a more scientific disposition of the vanes, and by the addition of Professor Thomson's whirlpool chamber.

Steel Bridge.—A bridge of the inverted bowstring form, constructed of puddled steel, has been erected by Major Adelsköld at the Gotha Elf, in Sweden. The span is $137\frac{1}{2}$ feet, and the total weight of the structure is only 50 tons. The maximum strain on the material is calculated at 8 tons per square inch, and all the parts of the bridge were tested to 16 tons per square inch.

Channel Bridge.—In addition to the tunnel schemes for carrying a railway across the English Channel, Mr. McClean is reported to have proposed a bridge.

Institute of Mechanical Engineers.—At the last meeting of this Society at Birmingham, a paper was read by Mr. John Robinson on Seller's self-adjusting Injector for feeding boilers, a most valuable improvement on the Giffard Injector, which is now so extensively used, making it automatic with a varying steam pressure. Also a paper by Mr. F. W. Webb on a curvilinear shaping machine, for finishing the curved inner face of locomotive wheels to a true circle.

Crumlin Viaduct.—This beautiful example of the Warren or triangular girder, which had become dangerous from the loosening of the joints, consequent on an insufficiency of bearing-area, has been thoroughly renovated,

and the wooden flooring replaced by an iron one. The structure is now probably stronger than when first erected.

Parabolic Governor.—Messrs. Smith & Jackson, of Keighley, have proposed a new form of pendulum governor, in which the balls are constrained to move in a parabolic arc. In this arrangement the balls may remain at any position in their range, and the governor revolve at one and the same speed; in other words, the governor cannot possibly continue to run faster or slower than its proper fixed speed, when the balls are anywhere within the limits of their range: and consequently, the range being made sufficient to completely shut or open the throttle-valve, the engine cannot possibly continue to run faster or slower than that fixed speed, without in the one case opening the valve wide, in the other closing it. This obviates the objection to the ordinary governor, which has a special rate for every position of the balls.

Fairlie's Locomotive for Steep Inclines.—The necessity of greater adhesion-weights in locomotives has led to the coupling of four, and even in extreme cases of six, pairs of wheels. For such engines, French engineers have for some time adopted four cylinders, grouping the wheels in two sets. Mr. Fairlie has now advanced one step further, and has adapted the four-cylinder-engine to railways with sharp curves, by arranging the two sets of wheels in two swivelling bogie frames. An engine of this description, built for the Queensland railways, was tried in August on the St. Helen's bank, which has an average gradient of 1 in 80. Up this bank the engine took a train weighing altogether, inclusive of the engine, 194 tons, at a speed varying from 24 to 13 miles per hour.

MEDICINE.

On the Movements of the Heart.—In a recent memoir Dr. Sibson describes his experiments on the movements of the heart, which were made on the ass under the influence of wourali, and on dogs subjected to chloroform. He found that the contraction of the ventricles takes place in every direction towards a region of rest, which in the right ventricle corresponds with the anterior papillary muscle in the left ventricle, with a situation about midway between apex and base. Simultaneously with the universal contraction of the ventricles there is universal distension of both auricles, the pulmonary artery and the aorlæ. The total amount of blood contained in the heart and great vessels is the same during both systole and diastole. During the ventricular contraction, however, the distribution of the blood, lessened towards the region of the apex, balances itself by being increased in that of the base, since the auricles and great vessels are enlarged, not only towards the ventricles, but also outwards and upwards. During ventricular dilatation the reverse takes place.

State of the Eye in Hemeralopia.—Signor Quaglini, of Pavia, has published the results of thirty cases of hemeralopia. The alterations he observed are briefly as follows:—(1) Whitish-grey haziness of the whole retina, especially around the disc, and along the retinal vessels after invading the disc itself. (2) Manifest congestion of the veins, which are tortuous and filled with blackish coagulated-looking blood. (3) The central arteries often

enlarged in the region of the disc. (4) In recent cases the disc looks red or roseate. (5) The obscuration of the retina ceases, but the arteries and veins become smaller and the contours of the disc lose their regularity, and are fringed by streaks of pigment.—Vide *Ophthalmic Review*, October.

Development of Epithelial Cancer in Internal Organs.—Dr. Otto Weber finds from researches made in the liver and lungs, that secondary cancrroid deposit exists in internal organs much more frequently than is believed. The epitheliomata in internal organs, he says, are developed at the expense of the nuclei of the interstitial connective tissue, and not of the proper epithelial cells of the organs. He gives several instances of the co-existence of epithelial cancer and tubercle in the same organ.

Structure of the Kidney.—M. Chrzonecsczewsky combats Henle's ideas on the structure of the kidney. He injects carminate of ammonia into the jugular vein of a rabbit; the carmine passes into the vessels and thence into the uriniferous tubes and the urine. To colour the vessels alone he ties the renal veins immediately after injecting the jugular, then the artery; to colour the uriniferous tubes only, he ties the ureter, and injects through the renal artery a saline solution, which removes all the colouring matter deposited in the vessels of the kidney. The principal results at which he has arrived are the following:—The uriniferous tubes end in three ways—in anastomoses, in *culs-de-sac*, and in the Malpighian corpuscles. The anastomoses, which are very numerous in man, in the calf, and in the pig, are met with chiefly in the cortical substance. The termination in *cul-de-sac* is very rare, but there is no doubt of its existence. The Malpighian corpuscles (or rather capsules) are continuous with the tortuous tubes alone, and each with only one. The Malpighian capsule is lined with pavement-epithelium; the internal surface of the glomerulus of vessels is also covered with epithelium, but of larger cubic cells, more resembling the tortuous tubes. The Malpighian capsules communicate with the flexuous tubes, and through them with the straight tubes; and all may be injected through the ureter. In the looped canals described by Henle two kinds are to be distinguished: 1. Some described already by Ferrein, found in the peripheral portion of the medullary substance, are merely loops of flexuous tubes burying themselves in this substance; 2. Others, reaching the summits of the pyramids, are merely vessels.

Production of Anencephalic Monsters.—M. Dareste, well known for his researches in teratology, has published a very able paper on the cause of these monsters. It appears that two theories have hitherto been framed to account for these phenomena, and it seems that though these two hypotheses apparently contradict each other, M. Dareste's discovery has harmonised their more important points of difference. It was thought by Haller and Morgagni that the cause lay in the existence of a dropsy of the spinal cord, which tended to destroy the nervous substance. Geoffrey St. Hilaire, on the other hand, looked upon the cause as an arrest of development. Both hypotheses are in some measure correct, according to the results of M. Dareste's enquiries; but Haller and Morgagni erred when they said that the effusion destroys the nervous substance. In point of fact, M. Dareste has discovered that the effusion appears before the nervous substance, and thus hinders its development. But this distinguished physiologist has gone a step further

than his predecessors in demonstrating that the effusion in question is the result of an extremely anæmic condition, which is the first unusual symptom that presents itself. In some instances he has seen this dropy affect both true and false *amnion*.—Vide *Lancet*, "Record of Sciences."

Homological Relations of the Scapula and Ilium.—Mr. St. George Mivart has just written an important paper upon the *Echidna Hystrix*, in which we find some novel suggestions as to the relations of the scapula and ilium. Mr. Mivart says that when we place the anterior and posterior limbs in a position for fair comparison, the two extensor borders being outwards, the elbow being drawn outwards and forwards, and the knee outwards and backwards, the suggestion naturally occurs that the bones from which they are suspended are rotated, as in fact they are naturally in *Galeopithecus*. This being done, the coracoid seems to answer to what Mr. Mivart believes to be its *true* homotype, the ischium; also the suprascapular notch seems to repeat the sacro-sciatic one, while the spine of the ischium with the lesser sacro-sciatic ligament attached to it "recalls to mind the prominence from the base of the coracoid with its coracoid ligament." Mr. Mivart thinks that the spine and acromium of the scapula are unrepresented in the ilium. In the echidna the part of the scapula which gives origin to the subscapularis looks backwards and outwards; hence Mr. Mivart enquires, Are we to regard this as the natural position, and consider the position of the bone in the higher animals as exceptional? Mr. Mivart concludes his memoir with the suggestion that they should be regarded as columnar bones, a character which they exhibit in a high degree in chelonians.

Duality of the Heart.—According to M. Dareste, the primitive duality of the heart is the immediate consequence of the primitive duality of the anterior laminae of the vascular area. In reality, the blastemæ, which farther on will form the heart, at first make their appearance as two small oblong masses, observable at the lower internal portion of each of these laminae, quite close to the point where they become united to form the apex of the retreating angle. These two blastemæ are completely separated, like the laminae from which they spring. At a later stage, when the two laminae become united on the median line, the two cardiac blastemæ whose development has kept pace with that of the laminae, also approximate on the median line, and speedily unite into a single mass, which forms what embryogenists have thought to be the primitive condition of the heart. Nevertheless, an indication of the primitive duality is still for some time to be met with; it is a groove which is situated at the anterior portion of the organ, and which arises from the fact that the junction of the two cardiac blastemæ has gone on from behind forwards, like those of the laminae of the vascular area, which serves to support them.—Vide *L'Institut*, November.

Origin of the Lymph Vessels.—M. Chrzoniszewsky asserts that the finer lymph-vessels take their rise from the anastomosing processes of the corpuscles of the connective tissues. He made observations on the peritoneal coat of fowls whose ureters had been tied some hours before death, and found that when the delicate serous membrane was examined in glycerine, the connective tissue corpuscles were filled with a finely granular mass of urates, and that the lymph-vessels were also filled with the same material

The union of the processes of the connective tissue corpuscles with the lymph-vessels could be distinctly seen. That the granular contents of the corpuscles and lymph-vessels were really urates was proved by the well-known reaction with nitric acid and ammonia. The author concludes, from these experiments, that the urates arise in the connective tissue, and are carried away from it by the lymph-vessels.—(*Virchow's Archiv.*, Jan. 1866).

A new Narcotic: Wrightia antidysenterica.—M. Theodore Husemann has been studying the effects of this plant. It is of Indian origin, and its bark and seeds are much employed in the East Indies as a remedy for dysentery, diarrhoea, indigestion, fevers, and bilious affections. M. Husemann has experimented on toads, frogs, pigeons, and rabbits. He finds that doses of from 150 to 200 milligrammes of alcoholic extract of the seeds is all but poisonous to batrachians, and that these animals never resist doses of from 250 to 300 milligrammes. Doses of from 2·5 to 4 grammes kill pigeons and rabbits, while rather smaller doses cause only a certain stupor. The effects of the poison become generally visible on whales about a quarter of an hour after its administration, and on pigeons and rabbits after from thirty to forty-five minutes; death takes place in the latter case at from three to four hours and a half. At first a paralysis of the muscles is apparent, then a suppression of the reflex motions. There is no noticeable alteration in the pupillary diameter, nor in the movements of the heart. Death results from the paralysis of the thoracic muscles.

Physiological Action of Helleborine and Helleboreine.—M. Marmé has been making some physiological experiments on batrachians, birds, and mammals, with the two active principles of hellebore, which he calls helleborine and helleboreine. The helleboreine acts on the heart in the same manner as digitalis. Used subcutaneously it acts in much smaller doses than digitalis, and similarly produces slackening of the pulse. In stronger doses, on the contrary, it causes an enormous acceleration, soon followed by a sudden paralysis of the heart. With regard to the respiration, its acceleration or slackening is in an inverse ratio to the change of the heart's beat; it is rapid at the commencement, slow at the end. Helleboreine produces violent vomitings and dysenteric diarrhoea, accompanied by acute pains, in birds, dogs, and cats. It singularly excites the secretion of urine, and produces hyperæmia of the pelvic organs, particularly in the female. After making allowance for its influence on the circulation and the respiration, it acts also on the nervous system, producing tremors and sometimes convulsions. *Helleborine.*—Helleborine has the property, in common with helleboreine, that it does not act on the external teguments, and that it sharply irritates the intestine.

Presence of Copper in the Animal Organism.—M. Blasius, by minute analyses, has established the presence of copper in the tissues of mammals. Some of M. Blasius' results are embodied in the following table:—

	Weight Grammes.	Proportion of Oxide of Copper to the 100.
Ox liver . . .	1865 . . .	0·0007
Sheep's liver . . .	474 . . .	0·0010
Liver of a man . . .	1440 . . .	inappreciable
Spleen of do . . .	101 . . .	0·0007
Kidneys of do . . .	200 . . .	0·0007
Heart of do . . .	200 . . .	0·0007

The Poisonous Action of Digitaline.—Dr. Brunton of Edinburgh, in his prize thesis, says this substance acts as a diuretic even in health. Poisonous doses first occasion diminished frequency, but increased strength of the cardiac pulsations, together with contraction of the capillaries. The slackening of the heart's speed is due to the direct action of poison upon the heart, and not to the increased resistance offered by the contracted capillaries. After a short time the pulse becomes irregular, the capillaries dilate, the arterial tension diminishes, and syncope is apt to supervene. Lastly, the pulse becomes very rapid, and stoppage of the heart in a state of contraction soon follows.

The Action of Aconitine.—Dr. Achscharumow arrives at the following conclusions:—1. Death is not due to paralysis of the respiratory muscles, but to stoppage of the heart from paralysis of its motor ganglia. 2. The first effect is irritation of the medulla oblongata, which is communicated to the vagi. 3. Paralysis of the vagi supervenes, from continued irritation. 4. The temperature and blood-pressure are lowered. 5. The peripheral nerve endings and trunks are entirely paralysed. 6. Reflex function of the spinal cord remains intact. 7. The brain is unaffected. 8. It has no local action on the pupil.—Vide *Reichert and Dubois Reymond's Archives*, No. 2, 1866.

METALLURGY, MINERALOGY, AND MINING.

Reported Discovery of Coal in South Australia.—It is asserted that a mine of anthracite has been discovered at Port Lincoln, South Australia. Mr. Hodgkiss, the owner of the land on which the deposit has been found, has claimed the reward of £5,000, offered three years ago to anyone finding a coal-mine in South Australia.

Roasting of Grey Copper-ores in Hungary.—At the Stefanshutte works for the smelting of the grey copper-ores, they use of the yellow ores only poor quartzose ore, which is necessary for fluxing. The processes, therefore, have a character quite different from that in other places, where the grey copper-ores form only a small part of the materials to be melted. One of the main progresses in the last years is the production of metallic antimony from grey copper-ores, since more than one-half of the regulus antimonii, which comes in the market from Hungary, is now produced from these ores.

Production of Steam by Employment of Petroleum.—Notwithstanding the assertion of the American Naval Commission, that no advantages are to be derived from the employment of petroleum as a substitute for coal, we find that the English Government is taking up the enquiry in a serious spirit. A contemporary informs us that Mr. Richardson, who is instituting experiments in burning petroleum and other oils, with a view of superseding the use of coals for steam purposes, has received permission from the Lords of the Admiralty to use a service boiler in Woolwich Dockyard for one week, in order to demonstrate the advantage of shale-oil as fuel. The trial has been requested by a number of shale-oil manufacturers in Wales and Scotland, and some scientific persons.

Corrosion of Ships.—Mr. Daft's proposition to protect the iron by zinc, by placing an intervening thickness of felt between these two metals, and which plan was approved of by the late Admiralty, has been tried. A trial of its efficiency obviously involved a question of time. Sixteen months having elapsed since the commencement of this experiment, the sheet of iron protected by a sheet of zinc, and a sheet of felt between the two, was raised from the action of the sea-water in Portsmouth Harbour, in the presence of the visiting Board of Admiralty. The result was satisfactory. The subsequent experiment, which brought the two metals in direct contact, was also highly satisfactory in its result.

Hardness of Silver.—Mr. Mathey, assayer at Loda, has shown that in even hard silver there is neither tin, lead, nor any other injurious metal. Its hardness, he asserts, is due solely to the high temperature at which silver is cast. By letting the crucible cool till a slight solid crust is formed on the surface of the fused metal, and casting at this moment, a soft silver with a brilliant cut is obtained.—Vide *Dingler's Polytechn. Journal*.

How to use Nitroglycerine.—In another number we gave a general account of the properties of nitroglycerine, and of the mode of employing this explosive substance; but as a recent and exact description has been published by Mr. E. Kopp, we translate it for our readers. Suppose, he says, it is desired to detach a layer of rocks. At a distance of from 2·5 to 3 metres from the outside, a mine-hole is dug of about 5 to 6 centimetres diameter and 2 to 3 metres depth. After having cleared this of dirt, water, and sand, 1,500 to 2,000 grammes of nitroglycerine are introduced, by means of a funnel. A small cylinder, of iron, cardboard, or wood, about 4 centimetres in diameter and 5 to 6 centimetres in height, is then introduced and filled with ordinary powder. This is fixed to a wick or ordinary mine-fuse, which penetrates into it to a certain depth, to assure the inflammation of the powder. By means of the match on the fuse, the cylinder is lowered; and by the feel the moment can be easily judged at which the cylinder reaches the surface of the glycerine. The match being then held firmly, fine sand is run into the hole until it is quite full. It is useless to compress or tamp the sand. The match is cut a few centimetres above the orifice, and set fire to. In eight or ten minutes, the burning of the wick having reached the cylinder, the powder inflames. A violent shock ensues, which instantaneously explodes the nitroglycerine. The explosion is so sudden that the sand has no time to be projected.

MICROSCOPY.

On the Improvement of the Compound Microscope.—In the *Microscopical Journal* for October, Mr. Fred Curtis gives the following remarks on the improvement of the Compound Microscope, as sequel to a contribution of July, 1863. He observes: "Concave mirrors in place of lenses in the eyepiece, so inclined as to reflect the body of rays into the form of a figure of 4, would afford a convenience of manipulation almost irrespective of the dimensions of the instrument. If approved, a mirror as objective also might

afford additional mechanical facilities. On a smaller scale the form of the letter N might be preferred. Attached to each objective should be a length of tube twice or more its focal distance. To avoid moving the body of the instrument, I would apply the adjustments to the stage. The experimental instrument of glasses described in 1863 performs admirably, on a white enamelled watch-case, on the surface of a flea, on solid deal, on mouse's hair, and on the surface of the pollens of whin, broom, and geranium, without condenser. The field is remarkably flat, and available at every part."

Smith's New Growing Slide.—Dr. John Barker, of Dublin, has devised an ingenious modification of Smith's new growing slide. It consists of a shallow glass box, as in Smith's, but both upper and lower plate having cut out of each a circle of about an inch in diameter; and a piece of glass tubing set therein and cemented, so as again to hermetically close the box. Immediately over the aperture thus made through and through the box, a circle of glass, a shade wider in diameter and rather thinner than an ordinary slide, is cemented, thus again closing the aperture through the box at one of the surfaces. The upper surface of this circle of glass forms the table on which the object for examination is placed. At the right-hand side, just beyond the edge of this circle of glass, and near the lower edge of the box, a small hole is drilled through the upper plate of the box, which is the feeding hole for the water, which is introduced into the box by a small opening ground away at the lower right-hand corner. The object is now covered by a square of thin covering glass in the usual way; one angle of the cover extends at the right-hand side beyond the circular table, and reaches so far as to cover the little feeding aperture in the box, and the flow is established. There is a little strip of glass cemented at the lower side to prevent the square cover slipping. This plan has the advantage of allowing the light to come up from the mirror, not through a stratum of water, however thin, but directly through a thin plate of glass, permitting, too, the use of the achromatic condenser if needful. Dr. Barker stated he had found this plan to act very well.

A Handy Cabinet for Microscopic Objects.—Mr. Collins, of Great Titchfield Street, has sent us a specimen of a slide-cabinet, which is certainly a marvel of simplicity, cheapness, and efficiency. It consists of a sort of card-board box provided with a cover, and whose front side, if we may use such an expression, lets down. Opening the box we see six neat papier-mâché drawers, each of which contains six compartments for slides, which are laid upon the flat. The great advantages of this case are: the economy of space, the convenience with which any of the drawers may be removed, the ease with which the names of the various objects may be observed, and the extreme lightness and portability of the case. We believe the cabinet was originally designed by Mr. Piper, and we commend it to the notice of our readers.

PHOTOGRAPHY.

Mr. Woodbury's Printing Process.—Certain of our contemporaries long since promised specimens of this new process, which have not up to the

present time been forthcoming. Doubts have therefore been publicly expressed as to its practical value. We have now reason for believing that the delay arose in each such case from Mr. Woodbury's desire to effect contemplated improvements before issuing other prints to the public, and which improvements have but recently been accomplished. The difficulty experienced of obtaining labourers sufficiently skilled to ensure the production of a large number of prints, possessing uniform excellence, has been overcome by substituting metal rollers for flat plates and causing them to revolve rapidly with a self-inking arrangement. Thus mechanical means do perfectly that wherein hand-labour had not proved satisfactory, and the prints are produced with a rapidity and certainty such as we obtain with the type-printing cylinder used in calico and newspaper printing. Another projected improvement is that of substituting ink of the kind used in ordinary printing for the pigmented gelatine, and this improvement, which we believe to be of vital importance, is, we are told, in a fair way of being accomplished. Several new applications of this important process have also been discovered. One is that of printing photographs on glass to serve as transparencies, etc. for decorative purposes, and for exhibition as magic-lantern slides; and others exist for transferring the photograph to wood, stone, ivory, or metal. It is also used for producing permanent *cartes de visite* at the very moderate cost of 9s. per hundred, after an outlay of twelve shillings for the metal intaglio. Attempts have been made to blend this process with that of chromo-lithography, but judging by the dull, flat, horny-looking specimen shown at the South London Photographic Society, a very slight degree of success has attended it, although some ill-advised speculator has, we understand, made such application the subject of a fresh patent. The process patented is, first, that of transferring the photograph to the lithographic stone; secondly, that of printing it in colours in the usual way; and thirdly, that of printing the photograph again *over* the coloured impression by the Woodbury process. The small value of the patent, and the objections to such a tedious inartistic roundabout process, are too palpable to need pointing out.

Another New (?) Lens.—Mr. J. Traill Taylor, a gentleman who has introduced many valuable practical suggestions and improvements in a peculiarly quiet unostentatious way, in the April of 1864 read, before the Photographic Society of Scotland, an optical paper, in the course of which he pointed out how, by altering the arrangement of Petzval's compound orthoscopic lens, the depth of its defining power could be very largely increased, in combination with a large field flat without a diaphragm. The only sacrifice made in this case was that of the microscopical degree of sharpness, which artists call hardness, and which gives photographs, more particularly when stereoscopic, that strangely unnatural and rigid appearance which is more suggestive of metal casts than of natural effect. This paper was duly published, and in photographic pages; but those critics who have no way of judging the value or merit of an invention but by what the inventor may please to claim for it himself, gave the discovery no good word, and so it speedily passed from their remembrance. But at the last meeting of the "London Photographic Society," the same improvement, effected by identically the same means, viz. the introduction of spherical aberration, was again brought forward by an optician, who awarded the merit of its discovery to a gentle-

man who, at the time Mr. Taylor's paper was read, edited a photographic contemporary. In this case, however, the reader of the paper was by no means backward in the use of "varnish," and verily he received his reward. The Journal of the Photographic Society, in its last issue, speaks of "the new (?) lens"—under which name it is already advertised for sale—as "an optical discovery, the importance of which cannot be overestimated," and "a service equal to that which Petzval did to photography itself in rendering it, so far as optical instruments are concerned, a thing at all possible!" If this is true, Mr. Taylor has reason to be proud.

A New Paper.—We believe that the use of collodio-chloride was introduced by Captain Dixon, and was first publicly announced, in connection with a new process, in the *Photographic News*, April 26, 1861. Among the various trifling modifications, and consequent applications, since introduced by photographers—each of whom has laid claim to the full merit of an original discovery and invention—the more recent is found in connection with a new paper for photographic printing, called "Leptographic." Numerous and valuable advantages have been claimed for this paper by the French company interested in its sale, but it must be remembered that if it is the collodio-chloride process, as experiments appear to demonstrate, in yet another of its various modifications—which, however, the manufacturers deny—all the disadvantages which have been urged against the one process are still in full force against the other. The Leptographic process has been successfully used to give a photographically sensitive surface to wood, canvas, leather, ivory, silk, and other surfaces; and is said to be specially suitable for enlargements. The paper is issued ready sensitised, and prints are produced on it with great rapidity.

Photographs in Natural Colours.—*A Photographic Canard.*—We believe the announcement—which our readers may remember—of a murderer having been convicted by his image being photographed from the retina of his victim's eye, once made with so much circumstance, emanated from a foreign correspondent to the *Morning Post*. Although the *Lancet* clearly demonstrated the extreme absurdity of the paragraph, yet it went the round of all our English papers, and after travelling abroad came back to us again, of course considerably augmented. The *Morning Post* has more recently been equally successful in starting a similar *canard* on its travels, through its Paris correspondent, who stated that M. Chambray, a French photographer, had discovered a means of producing photographs in natural colours, and declared that he, the Paris correspondent, had himself carefully investigated the wonderful process, and was satisfied and delighted with the perfection of what he called "the great chemical and art event of the day." This wonder, having been duly echoed and re-echoed, created quite a sensation amongst the credulous, and induced the Paris correspondent of the *British Journal of Photography* to investigate the matter, when it turned out that M. Chambray laid no claim to any such discovery, and that the supposed photographs in natural colours were merely ordinary photographs coloured at the back and rendered transparent.

M. Claudet's Process, as described in our last, has been placed before the Photographic Societies of London and Paris, and the opinions we expressed concerning it have been confirmed by the general opinion of the

photographers who attended these meetings. At the London Society, Mr. Mayal, Mr. Jabez Hughes, and others, condemned the thing both in principle and practice, and the President of the French Society wound up the unfavourable opinions expressed by stating that it was not in the direction M. Claudet had pointed out that photographers could hope to find real progress.

Presentation of Medals.—The long-promised medals of the London Photographic Society have at length been awarded as follows:—To Roger Fenton, as Founder of the Society; to Lady Hawarden, for artistic and photographic excellence (two medals); to H. P. Robinson, for '*composition*' photography; and to Messrs. Claudet, Williams, Joubert, England, Bedford, Thompson, Maddox, Toovey, Buxton, Macfarlane, Mudd, Lieut.-Col. Stuart Wortley, and Major Gresley.

Magic Cigar Tubes.—A toy application of photography has been introduced in the shape of cigar-tubes, on which, when smoked, a photograph gradually appears.

Permanent Photographs.—Messrs. Tichbourne and Robinson have ascertained that chloric and perchloric acids completely oxidise weak solutions of hyposulphite of soda, and on this principle base the following process. Prepare a solution of twenty-four grains of chlorate of baryta in each ounce of water, and add to this quantity twenty minims of perchloric acid (of about 12 per cent.). This is the eliminating liquid. Take a porcelain or other dish and place in it a pint of hot water, then add two ounces of the above solution. The bath is now ready. Having washed the prints sufficiently in the ordinary way, plunge them into the warm eliminating bath, and let them remain there for an hour or so. They afterwards need only to be washed with plain water, in order to cleanse the print, then to be dried and mounted.

Mr. Swan's Carbon Process.—At the meetings of the Photographic Societies some very attractive and beautiful examples of this process have been exhibited, speaking volumes for the perfection of its results. The inventor does not intend to charge for working his process, but will grant its use to any photographer who may choose to purchase the materials. One of the chief and best features of the process, in regard to the reproduction of works of art, is the fact that drawings in chalk or monochrome may be reproduced, not only with the faithfulness of a photographic fac-simile, but in the very material of the original. Thus a chalk drawing, red or black, is reproduced in chalk, a sepia or bistre drawing in sepia or bistre, &c. The paper is prepared in continuous lengths of 12 feet, coated with gelatine and pigment, is rendered sensitive by immersion in a saturated solution of bichromate of potash for one or two minutes. It is then dried and exposed either to the enlarged image of the solar camera or in contact with the negative, on the pigment side. Then it is mounted by the aid of a solution of india-rubber, pigment side down, on a piece of white paper, and both are next dried. After being rolled, the papers thus adhering are immersed in tepid water for about ten minutes, when the gelatine will become softened and the original paper can be removed, leaving the pigment attached to its second support by the india-rubber solution. By increasing the heat of the water the unaltered pigment and gelatine dissolves away, and the picture is completed. Washing in cold water removes the traces of chromic

salt, and after drying, a coat of clear gelatine brings to the next process that of transferring, which is accomplished by placing a damp mounting board on the gelatine surface and passing the two through a rolling press. This done, when quite dry a piece of cotton wool saturated with benzole rubbed over the surface of the paper attached to the benzole, softens the latter, and admits of the former's removal.

Photography and Navigation.—A Novel Application.—M. Carradi of Marseilles proposes to register the path of a ship, and its various tackings and evolutions, by means of photography. For this purpose he has contrived an instrument which he calls a "loxodograph," which consists of a compass placed below the ordinary ship's compass, so as to occupy the same relative position in the ship, and so that it can be compared from time to time with the normal instrument. Underneath the secondary compass is some simple clockwork, having for its object the unrolling of a band of sensitised paper, of a width equal to the diameter of the card of the compass. This paper is placed horizontally under the compass, and unrolls, longitudinally following the axis of the vessel. Underneath the disc of the compass, but above the paper, and placed at the north pole, is a lens, which projects a luminous point upon the paper below. Thus, if the ship pursue a straight line, from north to south, for example, the luminous point will be thrown upon the paper, and trace a straight line also from north to south; if, on the contrary, the ship move in an irregular broken course, the bright point will be shown on the paper in a line of the same character, seeing that the paper follows the ship's movements, whilst the luminous point remains stationary at the north. We extract this description from the *British Journal of Photography*.

Something Sensational.—A strange story is told in *Les Mondes*. A Dr. Marina, to advertise a method he had invented of preventing decomposition after death, had operated upon the body of a deceased literary man, named Pietro Martinis, who died on February 17 last. On the body being dug up, on June 17 last, it was so supple and life-like that it was dressed up in the author's "habit as he lived," taken to a glass room, and photographed.

PHYSICS.

New Instrument for Registering the Speed and Pressure of the Wind.—Mr. John Browning has nearly completed, under the supervision of the Astronomer Royal and Mr. Glaisher, a set of instruments for the above-mentioned purpose. The first, for registering the force of the wind, consists of a circular plate of metal, of a diameter equal to two square feet in area, supported by eight tempered steel springs. When the wind impinges on the circular plate the springs are brought consecutively into action, the stronger coming into play before the weaker have received any strain. The plate is kept constantly facing the wind by means of a direction-vane. From the plate a fine flexible wire is carried down through a hollow pillar which supports the vane, the whole apparatus being in a room below. The wire governs the motion of a pencil, which is made to traverse a table covered with slate, on which is strained a sheet of paper marked with the hours.

This table is moved by clockwork, and the pencil being regulated by the pressure-plate registers on the paper the pressure of the wind during every portion of the twenty-four hours. The instrument, which is capable of registering as light a pressure as even two or three ounces on the square foot, will in strong gales have to withstand a force of 40 lbs. to the square foot. —*Times*, September 13, 1866.

On a Means of Weakening the Intensity of the Sun's Rays at the Focus of Telescopic Object Glasses.—M. Leon Foucault proposes to alter the plan hitherto adopted for this purpose. He proposes to deposit a layer of metallic silver on the outer surface of the object-glass, by the means he has already so successfully adopted for silvering the concave glasses for reflecting telescopes. The metallic coating, whilst it possesses so brilliant a lustre, has also a transparency and limpidity which is comparable to the finest coloured glass, and as it may be regarded as a surface devoid of thickness, its addition to the object-glass will not interfere with the accuracy of its surface. By its means the instrument is protected against the heat of the solar rays, which are almost entirely reflected back towards the sky, whilst a minute quantity of blue light only penetrates through the metal, and is refracted in the ordinary manner, and forms at the focus a steady and clear image which can be observed without injury to the observer's sight. The contour of the solar disk is projected sharply against a black sky, the spots are marked with precision, and the faculæ, as well as the decrease of light towards the edge of the sun, are distinctly shown. The true colour of the sun is a little altered, owing to the preponderance of blue rays; but the gradations of intensity are well preserved, so that no detail is lost, whilst the eye after a short time becomes accustomed to the blueness, and does not observe it. The only drawback appears to be that this plan necessitates the sacrifice of an instrument, at least for a time, and the question appears to be, is the object to be gained worth the cost? M. Foucault thinks that it is.

On a New Kind of Acoustic Sand-Figures, and their Application to determine the Velocity of Sound in Solid Bodies and Gases.—Dr. Kundt adopts the following proceedings to determine the velocity of sound in solid bodies. He inserts a rod of the substance of a given length some little distance in a glass tube about four feet in length, and three-quarters of an inch in diameter, containing a little lycopodium and with stoppers of cork. The rod pushes the cork stopper before it, and is steadied in its position by a shoulder of cork where it enters the glass tube. The note of the rod being now educed is propagated to the air in the tube, and sand-waves are produced, from the length of which, compared with that of the sounding rod, the velocity of sound in the solid may be deduced. Dr. Kundt's experiments give for the velocity of sound in brass, 10·87; steel, 15·345; glass, 15·25; copper, 11·96.—Vide *Poggendorff's Annalen*.

On the Diffusion of Gases through Caoutchouc.—Professor Ryhe finds that when hydrogen gas is passed through india-rubber tubes it always contains traces of air and aqueous vapours. MM. Aronstein and Sirks examined this more fully, and found that common vulcanized, brown de-vulcanized, and pure non-vulcanized caoutchouc were all easily pervious to hydrogen, but that they could be rendered impermeable by a coating of asphalt dissolved in coal-oil.

On a Means of Utilizing the Phenomena of Supersaturation.—M. Jeanuel suggests that this phenomenon may be utilized in the purification of sulphate of soda and other commercial salts. For sulphate of soda, proceed as follows:—Take 300 grammes of this salt and 100 grammes of distilled water; dissolve at a temperature of 33° in a glass flask, and while this is going on, arrange a filter in a funnel and pour through it 500 grammes of warm water at about 50° . Then place the funnel on a wide-mouthed flask well rinsed with distilled water, pour the warm saline solution on the filter, and cover it with a plate of glass. The solution will entirely pass through without crystallizing, and will remain liquid in the flask even after cooling. When the funnel is removed, the solution, exposed to the air, rapidly crystallizes and becomes heated. When quite cold, decant the mother liquor. Sulphate of magnesia, sulphate of zinc, and carbonate of soda may be purified in a similar manner. The acetate and tartrate of soda, soluble in their water of crystallization at a temperature below 100° , may be easily filtered by this means. This process is not applicable to alum. M. Jeanuel proposes to use this phenomenon as a means of separating salts; thus, dissolve 335 grammes of nitre and 300 grammes of alum in 100 grammes of water; allow the mixture to cool without exposure to the air, and the nitre will crystallize out, whilst the alum will remain in a state of supersaturation. The separation of the two salts can thus be effected by decantation.

The Earth and Moon in Collision.—Mr. James Croll, who some time since asserted that owing to peculiar solar and lunar action the above extraordinary condition will eventually take place, has just published a paper reasserting the truth of his proposition. The theory was opposed by the Astronomer Royal and Professor William Thomson, who showed that, owing to the position of the tidal wave, the moon is drawn not exactly in the direction of the earth's centre of gravity, but a little to the east of that centre, and that in consequence of this she is made to recede from the earth. Her orbit is enlarged, and her angular motion diminished. This argument does not, in Mr. Croll's opinion, affect his view. The conditions described by Professor Thomson and the Astronomer Royal do not in the least degree prevent the consumption of the *vis viva* of the earth's motion round the common centre of gravity, although to a certain extent, at least, it must prevent this consumption from diminishing the moon's distance, and increasing her angular motion. But as this consumption of *vis viva* will go on through indefinite ages, if the present order of things remains unchanged, the earth and the moon must therefore ultimately come together.

The Dynamical Theory of Electricity.—Mr. Charles Brooke has addressed a letter to the Editor of the *Philosophical Magazine*, alleging that he sees more reason than ever for believing in the dynamical theory. He gives the following fact, as strongly confirmatory of the dynamical doctrine. It has long been known that if a bar of antimony and one of bismuth be connected, and a current be transmitted from antimony to bismuth, heat will be developed at the point of junction; and, on the contrary, if the current pass from bismuth to antimony, cold will be produced. Now it has occurred to Mr. Brooke, that if in the former, as in all cases where heat is developed in the passage of a current "a portion of *electric potential* is converted into thermic potential, or heat," there ought in the latter case to be an inductive

conversion of thermic into electric potential; and if so, there should be a loss of current in the first instance, and again in the second. And such, says Mr. Brooke, "appears to be the fact." "On duly balancing the thermo-element above mentioned in a Wheatstone's bridge, the deflection of the needle followed the direction of the current, and the anticipated loss or gain of current was fully realized."

Submarine Photography.—M. Bazin illuminates the bottom of the sea by means of electric light, for the purpose of discovering the position of sunken vessels, &c. His photographic studio consists of a strong iron box, braced transversely, and admitting the light through lens-shaped watertight windows; and he can remain in it without inconvenience for about ten minutes. He has, it is said, produced sharp and well-defined photographs, suited to render easy the recovery of objects sunk to considerable depths, and has already worked at depths approaching to 300 feet.—*Builder.*

On the Halo of $22\frac{1}{2}^{\circ}$.—Professor Miller read a paper on this subject before the Cambridge Philosophical Society. He commenced by a slight sketch of the difficulties which had been experienced in accounting for the phenomenon of haloes, especially in those of 46° . After mentioning some experiments by himself and Mr. Bravais, which showed that the larger halo was best explained by supposing refraction to take place through the terminal and one of the lateral faces of the hexagonal prisms of the ice crystal, Professor Muller described the results of examining a halo radius of $22\frac{1}{2}^{\circ}$, which had been seen in Russia to be formed on the ground; this, and a similar halo seen (together with that of 46°) by Professor Ritz during a "tourmente" in the Kandergrund, proved the present theory, that haloes were caused by the refraction of the sun's rays through ice crystals, to be right. He also gave an account of some experiments which, during the past summer, he had made at Rosenlain, at a height of 4,400 feet, with a polariscope, which showed that the light of a halo was such as is polarized by refraction.

The Physics of a Meteorite.—In a recent note in the Proceedings of the Royal Society, the Rev. Samuel Haughton, of Trinity College, Dublin, gives a very graphic account of the fall of an aerolite. The fire-ball was seen by two peasants, who have given the following written statement of their observations; and since the facts described by these ignorant men correspond exactly with the facts theoretically believed to present themselves, we think the description of the highest interest. It is headed, The Statement of Eye-witnesses, and runs as follows: "I, John Johnson, of the parish of Clonoulty near Cashel, County Tipperary, was walking across my potato-garden at the back of my house, in company with Michael Falvy and William Furlong, on August 12, 1865, at 7 P.M. when I heard a clap, like the shot out of a cannon, very quick and not like thunder; this was followed by a buzzing noise which continued for about a quarter of an hour, when it came over our heads, and looking up, we saw an object falling down in a slanting direction; we were frightened at the speed, which was so great that we could scarcely notice it; but after it fell we proceeded to look for it, and found it at a distance of forty yards, half-buried in the ground, where it had struck the top of a potato-drill. We were some time looking for it (a longer time than that during which we had heard the noise.) On taking up the

stone we found it warm (milk warm) but not enough to be inconvenient. The next day it was given up to Lord Hawarden."

How to equalise the temperature of Rooms.—The late Mr. Appold, whose house was always one of the London curiosities from the circumstance that it was ventilated throughout by means of steam apparatus, invented a most ingenious automatic instrument for equalising and maintaining a fixed temperature of a room. The apparatus has been presented by his widow to the Royal Society, and was fully described at a recent meeting by Mr. Gassiot. The instrument consists of a glass tube having bulbs at each end. The tube is filled, as also about half of each bulb, with mercury, the lower bulb containing ether to the depth of half an inch, which floats on the mercury. The tube is secured to a plate of boxwood, and supported on knife-edges, on which it turns freely. At the end of the plate underneath the highest bulb, is a lever, to which a string is attached. This string is carried, by means of bell-cranks, to the supply-valve of a gas-stove or the damper of a furnace.

The instrument acts in the following manner: Supposing the stove to be lighted and to have raised the temperature more than is required, the heat will convert a portion of the ether in the lower bulb into vapour. The expansion of this vapour drives a quantity of the mercury out of the bulb underneath it through the tube into the upper bulb. The end to which the mercury has been driven being thus rendered the heaviest falls, and motion being communicated by the lever to the string, this closes the supply-valve or damper of the stove or furnace. Of course, if this should be carried beyond the required extent, the reverse action will take place.

ZOOLOGY AND COMPARATIVE ANATOMY.

Artificial Birds' Nests.—The societies formed for the protection of insectivorous birds in Switzerland, are now setting up artificial nests. One of the members of a society of this description, who lives in Vevey, having observed that many species of the kind mentioned select for nests the holes they find in the branches of rotten trees, and that they consequently do not find it easy to settle in orchards, where all the trees are in good condition, began, twenty-five years ago, to set up rotten trunks in his grounds; and since then he has had no need to trouble himself in the least about clearing away caterpillars, that care being entirely left to the birds, who perform their duty admirably. His neighbours, on the contrary, who have not had this foresight, have had their orchards laid waste by insects. The Yverdon Society have gone the length of placing artificial nests even in the public walks and communal forests, on the borders of the lawns, &c. All those nests are now inhabited by hedge-sparrows, redstarts, creepers, and tomits, all which may be found in Switzerland as high up as the perpetual snow-line. The same practice has found its way into Germany.

The Darwinian Theory and the Heliconidæ.—Mr Wallace brought before the British Association the following facts confirmatory of the Darwinian theory relating to the Heliconidæ, one of the family of Lepidiptera. The Heliconidæ, a group of butterflies with a powerful odour, such as to cause

birds to avoid eating them, were simulated by the females of another group which had no smell, and might otherwise fall ready victims to birds. By their great resemblance to the obnoxious butterflies, the scentless females were enabled to escape pursuit and deposit their eggs. In different regions there were different species, thus imitating and being imitated. This case is a crucial test of the truth of the Darwinian doctrine. The females least like the *Heliconidæ* had always been more subject to destruction, and consequently, by the process of natural selection, the present state of very close resemblance had resulted.

Specific Relations of the Pig.—M. Sauson asserts that the domestic pig is not descended from the wild boar; the pig having only five lumbar vertebrae, whilst the boar has six.

The White Ant.—The Rev. T. Barry of St. Jude's, Randwick, asserts that the only timber that can effectually resist the white ant is the Jarrah, or Western Australian mahogany; which is never eaten nor never decays in the ground.

The Dog, the Ara, and the Frog.—These animals, according to one of our contemporaries, have disappeared from Martinique and Gadeloupe, since the French occupation.

A Rare Sponge.—The British Museum has lately received a series of specimens of the beautiful sponge called Venus's flower-basket.—(*Euplectella speciosum*).

Echinus Lividus.—Dr. Alcock, in a paper read before the Literary and Philosophical Society of Manchester, described particularly the mechanism of the teeth and jaws of this animal. He showed, by a dissection of the parts, that the statement made both by Professor Owen and Professor Rymer Jones, that the striated surfaces of the jaws are used to comminute the food is incorrect, for the whole of these surfaces is occupied by muscle, and is altogether outside the pharynx, through which the food passes. The specimens examined by Dr. Alcock were from Roundstone Bay.

An Acarus in the Pigeon.—In the last number of the *Microscopical Journal*, Mr. Charles Robertson, Demonstrator of Anatomy at Oxford, describes a hitherto unknown species of acarus, which he found when dissecting a pigeon. He states that the specimens found by him are small, oval, white, maggot-like animals, distinctly visible to the naked eye, and are found chiefly amongst the connective-tissue of the skin, the large veins near the heart, and on the surface of the pericardium. When few are found, they generally adhere closely to the surface of the pericardium, and to the large veins near the heart; if the veins have been previously injected with size and vermilion, the white transparent acari are seen very distinctly on their red delicate walls. All the examples which Mr. Robertson examined were very transparent without any trace of well-defined digestive or generative organs, even when examined with the highest powers. The body does not generally present any trace of constrictions, but in a few examples one or two faint lines were observed, giving the body a segmented appearance, but this may be caused by a mere folding of the soft cuticle. On the anterior and inferior surface of the body a ridge extends inwards and downwards from the base of the anterior pair of legs, and unites with a median single backward ridge. A similar ridge runs in the same

direction from the base of the second pair of legs; but instead of meeting, as in the first pair in the median line, are united by a transverse ridge, and a similar ridge is continued backwards from the points where this line joins those from the limbs. This arrangement reminds one of the head of the larva of hexapod insect. No trace of palpi, mandibles, or suckers were found. Short jointed legs were found in all the specimens examined. From the above description it will be seen that this acarus agrees with sarcoptes for having a considerable interval between the second and third pairs of legs, and the absence of a furrow between them.

Rearing the Tænia echinococcus.—We believe the *Tænia echinococcus* has not hitherto been successfully reared in this country as a matter of experiment. It is therefore satisfactory to learn from a paper presented to the Royal Society by Mr. Edward Nettlehip, that this gentleman has cultivated the echinococcus in the common dog. The following is a brief statement of the experiment.—On March 28, 1863, the liver and lungs of a sheep were obtained from Clare Market; they contained numerous echinococcus hydatids; in some the outer cyst was partly calcified, but all the hydatids contained clear fluid, and great numbers of scoloces attached to the endocyst within two hours of the death of the sheep to which the organs belonged. Two or three of the smaller hydatids were given to a young dog about six months old—the hydatid being previously punctured—and the collapsed cyst administered. The dog was then made to drink the fluid of the cyst in which some echinococci were floating. On May 15 (the forty-seventh day after the first feeding), the animal was killed, and his intestines were examined. In the first ten inches of bowel below the pylorus there were no tæniæ; at that distance a single tænia echinococcus appeared, moving actively; for the next two or three inches there were none, but at fourteen inches below the pylorus several more appeared, and immediately after this they became so numerous as to present almost the appearance of distended lacteals: this continued for about a foot in extent, and then they gradually became less numerous, and ceased at about three feet from the pyloric orifice.

The Secreting Organs of Hemiptera.—Mr. Blanchard presented, accompanied by an analysis, a memoir of M. Jules Künkél, upon the organs of secretion of the Hemiptera. The author has, in the first place, thoroughly studied the salivary glands of these insects, a subject on which our knowledge is still very imperfect. He then extended his investigations to the organs which produce the sickening odour of bugs. The gland which exhales this odorous matter is, as we are aware, situated on the ventral or thoracic front of these animals, at the level of the two anterior legs; but the nymphæ and the larvæ are endowed with the same odour, though they do not possess the secreting gland. M. Künkél has discovered that this organ is replaced in the larvæ by two dorsal pouches. When the insect undergoes its last metamorphosis, these two pouches become atrophied, while the ventral pouch, which is completely independent of it, becomes developed. It is easy to comprehend the purpose of nature in this substitution. The larva not having any wings, makes very good use of the two pouches which are on its back, in the most favourable situation, for driving away its enemies; but if these two pouches existed in the same situation on

the perfect insect, they would be concealed by the wings, and the diffusion of the odour could not occur.

On the Development of Small Acari in Potatoes.—M. Guérin de Menneville exhibited at a late meeting of the French Academy some specimens of potatoes covered with acari, but appearing to be perfectly sound. M. Guérin Menneville remarked that the late two months of wet weather had produced myriads of acari, known as *Tyroglyphus feculae*, on the Australian and other varieties of potato growing on the Imperial farm at Vincennes. It seems at present uncertain whether this immense crop of acari is the consequence of the disease in the potato, or the more or less proximate cause of a change in the tubercle, which will eventually manifest itself.

Reproduction of the Limbs in the Newt.—M. Philippeaux has been performing some experiments with the view of ascertaining whether the limbs of newts, if completely extirpated, would be regenerated. He found in numerous instances that when he extirpated the scapula, there was not the slightest sign of regeneration. On the contrary, when M. Philippeaux amputated the limb, leaving the basilar portion, it was entirely reproduced, with all its osseous portions. Experiments of the same nature on fishes have had a similar result, and M. Philippeaux deduces as a general fact, at least amongst the vertebrata, that no organ will grow again unless a portion remains in its place.

On the Structure of the Cornea in Reptiles.—Dr. Lightbody, taking the tortoise as a type, gives the following account of the structure of the cornea of the tortoise. It is between that of mammals and fish; the lamellæ are thin and well marked, the corpuscles small and few, but pretty regularly scattered through the whole thickness. The bundles are very broad, and have almost lost their individuality, blending with their neighbours by their margins. They are also arranged, as in birds, at right angles to those that occur immediately above and below them. The corpuscles are fusiform, and are arranged principally in two directions, one at right angles to the other. The sensor nerves are very large and strong, with the cells well marked and pretty numerous.—*Vide Journal of Anat. Phys.*, No. 1.

The Nerves in Insects.—In the last number of the *Microscopical Journal* Dr. Moxon describes the arrangement of the nervous system in the larva of a species of water-gnat. He opposes Dr. Lionel Beale's views in the strongest terms, alleging that the nerves by no means end in delicate reticulations, but, as M. Kuhne asserts, end in distinct solid cones or masses. The nervous fibres, he states, end in the nuclei on the surface of the sarcolemma. It seems to us, however, that an important objection may be raised to Dr. Moxon's views in the fact which he himself adduces, viz. that the larvæ in which he saw this arrangement of the nuclei most distinctly were those which had been reduced to what he calls a dropsical condition by forty-eight hours' confinement in airless water. Dr. Beale's observations have shown us that, in order to look for the terminations of the nerve fibres, we must take the larva and prepare specimens from it at the moment of its death, and examine them without delay. Dr. Beale did this at the time of the Croonian lecture to the Royal Society, and he then demonstrated satisfactorily that the nerves do not end, so to speak, but form numerous extremely delicate fibres, which are arranged in a complete network.

Action of Electricity on Noctiluca.—Some very curious experiments, illustrative of the action of electricity on this curious infusorian, have recently been made by MM. Robin and Legros. These authorities deny that the phosphorescent powers are confined to any particular part of the creature's body, and they further allege that when a current of electricity is passed into a vessel of water containing noctilucae, all those specimens which lie between the poles of the battery are in a state of brilliant phosphorescence; and, further, this condition is increased or diminished according as the circuit is complete or arrested.

The Linguatulæ of Serpents.—M. Jacquart has published a memoir, accompanied by illustrations, on the above subject. It is said that he has demonstrated the presence of a subœsophagial ganglion, but that he has been unable to find a cerebriferous ganglion. M. Jacquart states that the larvæ of Linguatulæ are just like those of the Lernææ.

Development of the Bothriocephalus latus.—Herr Knoch, from experiments made on various animals, arrives at the conclusion that the embryos of the *Bothriocephalus latus*, introduced directly into the intestinal canal of mammals, do not make any movements in the organs of these animals. This peculiarity causes them to differ from the embryos of tæniae. They also pass through all the phases of their development, attaining the scolex stage, and afterwards to their sexual development, without going through the intermediate state of cysticercis. Herr Knoch's experiments establish definitely that the embryos of *Bothriocephalus latus* become developed in the intestinal canal only, at all stages of their existence.



RECENT DISCOVERIES IN INSECT EMBRYOGENY.

By HENRY FRIPP, M.D.,

Lecturer on Physiology in the Bristol Medical School.

Nam quodcunque suis mutatum finibus exit
Continuo hoc mors est illius quod fuit ante.

For what from its own confines changed doth pass
Is straight the death of what before it was.

THE audacious simplicity of Topsy, who, unconscious of parentage, promptly seized upon the only plausible explanation of her existence that presented itself, has excited hearty laughter from many a reader of "Uncle Tom." But, though more experienced in catechisms than rude and ignorant Topsy, the most accomplished young lady might well have failed to answer so perplexing a question of origin with equal astuteness and confidence. In fact, the profound philosophy which lurks beneath Topsy's intuition, that not having been "born" she must have "grewed," does not appear to have met with due acknowledgment. No logician could have extricated himself better from a dilemma forced upon him by false premises. No zoologist could have more scientifically evaded a question he was not prepared to solve. No professor of physiology could have more deftly sheltered himself in the chaos of confused notions that hangs cloud-like over the boundary lines that separate the phenomena of growth from those of reproduction!

Nor is poor Topsy singular in her preference of a ready-made faith, which shuts out every doubt, over an hypothesis which might engender uncomfortable suspicions of ignorance. The world in general does not willingly unsettle itself in matters of fact and opinion, or show itself anxious to reopen questions assumed to have been definitely settled, though this seeming stability of fact and opinion may be rather due to the exhaustion of disputants, and the repose which follows temporary concessions, or perhaps to momentary indifference and disinclination to force an argument to its logical conclusion, for which a slow moving public opinion may not be prepared.

And yet nothing is more certain than that, during the same

or some future period, every fact and opinion of present or past times will again be called in question, rediscussed, and dealt with according to the knowledge and fashion of the day; to meet, perhaps, the fate that it escaped before of being criticised, annihilated, and cast into the limbo of past erroneous beliefs, or perhaps to come forth re-certificated and raised in significance as a golden truth, which has passed unscathed through the trial by fire, and shines the brighter for the friction it has undergone.

This re-sifting of fact and recoil of opinion, is most active when a scientific dogma, established on a scarcely secure footing, is suddenly brought into collision with unexpected and conflicting testimony: some discovery, for instance, which is seemingly at variance with accepted belief, or which necessitates a new interpretation of old theory. And such is the actual condition, at this present moment, of that branch of physiological science which relates to embryogeny, and more especially to the structure and properties of "ova." We purpose, in this article, to make our readers acquainted with the facts ascertained by recent labours of zoologists, who have given us an account of their researches. The interpretation of the phenomena to be described would lead us beyond our present limits, as it involves a complete review of the doctrines of embryology. But a brief indication of the probable bearing of these discoveries on the general doctrine of genesis may, perhaps, prove interesting to the general reader.

The facts, to which we now direct attention, have been investigated by several foreign naturalists during the last few years, and will be related in order of their discovery.

1. Professor Wagner, of Casan, found under the bark of a dead ash branch a grub, which proved to be the larva of an insect belonging to the family Cecidomyia. His attention was specially arrested by observing that this grub contained within its own body a number of similar grubs of different size and in different stages of development. He watched their growth, from the time of their first appearance as a small organised body in the midst of the fatty tissue of the parent, up to the period of their complete larval organisation. The presence of larva inside the body of another did not at first surprise him, as it is a well-known occurrence in the history of certain insects, whose eggs and larva have been found inside caterpillars of a different species, which have been selected as a temporary home.

But the larva found and examined by Wagner, contained an internal brood of *its own species*, which was developed from a germ mass belonging to itself, and not from eggs deposited by an enemy,* though in both cases the unfortunate parent is de-

* As in the case of the ichneumon fly, which deposits its eggs in the caterpillar of the Pieris; for a good account of which curious history the

voured by the cannibal it has sheltered or procreated. The case, therefore, is one of true larval propagation, or, as it is usually termed, "agamic reproduction." The organic matter which produces the brood increases as the larvæ develop, and the membrane in which it is enclosed serves ultimately as an investment, a "cocoon" for each young embryo before it is disengaged and thrown into the general cavity of the body.

This reproduction of larval broods continued from August till May, when the last set of larvæ acquired sexually distinct characters, after passing through the usual metamorphosis, and becoming mature insects. We had occasion, in a recent number, to describe the larvation of the aphid, and it seems here worthy of remark, that the time of year at which viviparous larvation occurs in the aphid, is exactly the contrary of that during which the propagation of the recently discovered *Cecidomyia* larvæ goes on. This fact appears to militate against the hypothesis that the functional activity of the reproductive organ depends on the influence of external temperature, but, on the contrary, favours the assumption that it depends rather on the supply of food, the aphid obtaining its nourishment from the summer juices of plants, whilst the *winter* larva of the *Cecidomyia* feeds on aliment prepared and deposited under the young bark after the sap changes of the warm season.

But this phase of reproduction proved to be transitory; for, as summer advanced, the larva became a pupa, in which sexually distinct forms were already visible, and, in the course of four days, perfect male and female insects appeared. The insect proved to be dipterous. The male, having an expansion of wing equal to that of the female, but a comparatively much slighter body, possesses considerable power of flight. The female is, as usual, a larger-bodied insect, and produces five remarkably large eggs, which fill the whole abdomen, and contain a yolk-mass, from which the fatty tissue of the new larva is derived. The successive larval broods are, in turn, nourished at the expense of this fatty substance.

The cycle of genetic phenomena is the same, therefore, as in other creatures in whom "alternate generations" are observed. The insect egg has a smooth shell, and is furnished with a funnel-shaped open-mouthed micropyle. The first larva developed from this egg contains fatty tissue from which the subsequent broods spring, according to Wagner, who (at the time of his published memoir), affirmed that no special reproductive organ existed. This view of the origin of the larval progeny coincides, therefore, with Wagner's account of the histologic relations of the germ elements. He describes the embryonal

reader is referred to an interesting chapter in Dr. Lawson's felicitous translation of Quatrefages' work on metamorphosis (page 74 *et seq.*).

development as commencing in the fatty tissue of the first larva, from which tissue small portions are separated. These, at first grouped together, become afterwards detached in single portions; their fatty contents become granular; and from these vitelline cells and a germ-cell are formed, which go through rapid development. The Professor's observations led him further to the conclusion that the fatty tissue of the larva is itself a residue of the original yolk of the egg of the summer insect, and is therefore endowed with formative powers and a speciality of function, in virtue of which germs are produced, which undergo rapid transformation, and thus play the part of pseudova, as observed in other insects. If, however, this fatty tissue be an actual residue of vitelline matter, it is obviously misnamed.

2. Dr. Meinert, of Copenhagen, was the next to discover the *Cecedomyia* larva (under the bark of a beech tree), and to watch the larval propagation. After following its final metamorphosis into an insect, he was enabled to describe and name it, and he designates it *Miastor Metraloas*. He also assents to Wagner's opinion respecting the origin of the larval germ from the fatty tissue, and agrees in considering this tissue as part of the original formative material derived from the insect egg.

3. Professor Pagenstecher, of Heidelberg, next took up the investigation. This observer met with similar but smaller larvæ (belonging to another species) in the musty refuse of beet-root that had been used in a sugar manufactory. This refuse matter (after extraction of sugar), which was in a state of decomposition, contained abundance of other insect life (larvæ of Coleoptera, Myriopoda, Anguillulæ, Podura, &c.), and was sent to him for examination, because cattle fed with it became diseased.

According to this observer, the fatty tissue has no direct relation to the germs of the larval broods. These appeared to be, and are spoken of by him as true "ova." The smallest observed were $\frac{1}{800}$ th inch in length, increasing gradually to $\frac{1}{300}$ th inch. He explains the great increase of bulk which the ova gain during development as the result of ordinary nutritive imbibition, and *not* of any absorption of the fatty tissue, which, however, disappears gradually, as the changes of development go on. The "ova" (or germs) were found in their earliest stage chiefly in the neighbourhood of the posterior segments of the body in the subcutaneous cellular layer. As they grew larger, they moved forward, and were lodged in the free spaces between the viscera. The ova at this time consist of a spheroid mass, whose outer circle is formed by a layer of clear globules, within which is an inner mass, composed of granular particles, interspersed with vacuoles. There is no organic union with the fatty tissue, the ova lying free in the general cavity (or visceral interspaces). The embryonal masses described by Wagner have, says Pagen-

stecher, a totally different aspect from these germs or ova. And the latter observer conjectures, that their origin might be traced back to one or all of three distinct histologic sources noticed by him:—1st, to cells embedded in a fine granular mass, situated around the intestine in the last larval segment; 2nd, to cells appearing very prominent immediately under the integument which unites the two last segments of the body; and, 3rd, to the subcuticular layer of cells before mentioned. Pagenstecher was unable (from the dying off of his larvæ) to carry on his researches, so as to discover a special reproductive organ.

His account of the further development of these ova is as follows. By a process of segmentation, a vitelline mass is formed under its enveloping vitelline membrane, during which process the outer sphere of clear globules disappears. Then an embryonal cell-layer (including a number of oil-drops) separates itself from the vitelline mass. These two separate parts increase rapidly, and with equal volume at first, but as the development proceeds, the embryonal layer gradually overlaps the yolk-mass towards that end which becomes the head of the embryo. In larvæ prematurely taken out of their envelopes, the residual yolk-mass is found pushed back to the posterior dorsal region, and is easily recognised. It might, therefore, be supposed to become transformed into fatty tissue, and the subsequent larval propagation thus brought into a certain genetic connection with the primal evolution of this fatty, or rather formative, material, derived from the original substance of the true egg. The idea of a true genetic descent is, by this explanation, still kept in view. As development proceeds, the parent larva is gradually filled and swelled out in form by the increase of size of the progeny within. Pagenstecher observed that the young broods undergo at least one moult during their growth. Each embryo now shows contractile and extensile movements of its own, and having broken through its egg-coverings, moves freely about in the cavity of the parent body. The parent larva then secretes from the inner surface of its skin (or subcuticular lining-cell membrane), a kind of second inner skin, which is, however, incomplete at the extremities. With these two skins it still lives for a time, making movements as of extrication, which sometimes cause the outer skin to give way. On ceasing to live, the parent becomes a sort of pupa covering, or substitute for it, to the brood within, which voraciously devours the maternal viscera. Pagenstecher found in his beetroot refuse many empty perforated sacs, the remains of the parents from which the young had escaped.

This observer thus sums up his record:—From some part of the body, not yet determined, ovals are detached, which fall free in the larval body, and are transformed into ova by a

normal process of development. Each ovum produces an embryo without previous fertilisation. The parent larva undergoes no metamorphosis, and never becomes a perfect insect. It may, however, transform itself into an inactive nymph, enclosing the young brood when completely grown. The evolution and growth of the ovum and its embryo goes on at first at the expense of the parent larva's circulating fluid, afterwards by absorption of the nutritive matter previously amassed in the fatty tissue. Finally, when the embryos are liberated from their egg-coverings, they feed on the viscera of the dead parent. The generation so produced, reproduces in its turn other generations. Pagenstecher concludes, that this form of non-sexual reproduction is similar to that of the aphis, and that a germ-producing organ will be discovered by further observation.

4. In the month of March, 1865, M. Ganine announced, in a paper read before the Academy of St. Petersburg, that he had found in the worm-eaten planks of buildings, and in worm-eaten pasteboard, wood, and in other places, larvæ similar to those examined by Wagner and Pagenstecher, which, holding a middle place between these, differed slightly in appearance, but which propagated in the same way. M. Ganine verifies the surmise of Pagenstecher respecting the existence of a special reproductive organ. He found that the germs or ovules were not generated in or by the fatty tissue, but that they proceeded from small sacs, which he calls ovaries. These organs, two in number, are placed symmetrically on either side of the median line, at the eleventh segment of the body of the young larva, and lodged in a small recess excavated on the inner edge of the fatty tissue.

Each "ovary" is formed by a thin transparent sac, of an oval shape, intimately adherent to the fatty tissue. The sac is filled with a clear fluid, containing a few granules, and two or three small cells. As the larva grows its ovaries increase in size also, and become detached from the surrounding tissue, with which they remain connected only by two fine filaments. Whilst this change of size occurs, germs or "pseud ova" are developed. First of all, the granular contents multiply, and form corpuscles by aggregation. Some of these corpuscles are transformed into cellulæ, by being grouped together and enclosed in a membranous envelope. These cellulæ are seen, at first, only on the side of the ovary, projecting as half circles: by degrees they enlarge, and, amidst the doubly outlined granules which fill them, a single larger one may be seen which represents the "germinal vesicle," with its nucleus. This disappears at a later period, or is confounded with other granules. In the subsequent development each young "pseud ovum" is covered with a thick viscid refractive layer; but the development does not go on contemporaneously in all the cellulæ, or equally in

the two ovaries. The most mature are collected at the posterior margin of the ovary, and their detachment occurs at intervals corresponding with the period of maturity of each "pseud ovum." After quitting, or even whilst within the "ovary," the yolk begins to form, first as fine opaque granules, scattered amongst the primitive cellules at one end (or pole), soon after which fatty particles with strongly marked outlines appear, and the ovum acquires an ovoid shape. The further development takes place after the ovum has left the ovary, and consists simply in an increase of yolk elements, which gradually fill the whole egg, and conceal from the observer what is taking place with the granules and primitive cellules. The ova, when let loose in the abdominal cavity, collect together at the posterior segments of the parent body, but, as the embryos grow, they reach by degrees the middle and anterior segments. When they have attained their full development they escape, first, from their embryonal envelopes, and then rupture the skin of the parent larva, to enter life upon their own account.

In the fully developed ovum the first changes observed are the formation, 1st, of a blastodermic layer on the surface of the yolk, and 2nd, of a layer of viscid matter, which soon gives place to a sphere composed of a regular layer of small clear cells. This, also, soon disappears. The form of the ovum has, meanwhile, undergone a change by the swelling of the ventral side. The embryo is developed from a clear, finely granulated mass, seen at the surface of the yolk. As it grows, the yolk disappears, but a part remains heaped up at the back of the embryo, and is afterwards transformed into fatty tissue.

Thus all observers agree in representing the yolk of the original insect egg as not wholly expended in the evolution of the first larva. But Ganine and Pagenstecher oppose the statements of Wagner and Meinert, that the fatty matter possesses the formative property attributed to it by them.

5. We now come to the observations of Leuckart, for the full account of which we refer our readers to the translation by Mr. Dallas, published in the March number of the *Magazine of Natural History* (of the year 1866). The larvæ examined by Leuckart were found under the bark of a dead apple tree, and belong to the species *Oligarces* (determined by Meinert). The origin of the free germs was traced (as by Ganine) to two small bodies (primitive germ stock), situated immediately under the skin of the eleventh segment of the larval body, and fixed by suspensory ligaments to the Malpighian vessels.

These germ masses consist of a number of clear cells, each of which contains several vesicular nuclei. The cells lie in a granular protoplasm, the whole being enclosed within a fine membranous investment (the "ovarial sac" of Ganine).

After a time, these clear cells are found to contain a number of small cells, derived from the vesicular nuclei. By successive development each cell is gradually transformed into a "germ ball," which, when detached from the primitive germ mass, consists of a membranous envelope, lined by an epithelial layer of cells (corresponding to the sphere of clear cells described and prepared by Pagenstecher), within which are a number of cells (the developed vesicular nuclei), themselves containing a fresh set of vesicular nuclei. Thus, the "germ stock" of Leuckart, from which his "germ balls" are derived, corresponds to the "ovary" of Ganine: the "germ ball" corresponds to the "pseud ovum" of Ganine, and is found loose in the larval body. In the physiological interpretation of these parts, our authors diverge considerably. Leuckart dissents from the nomenclature of previous observers, denying that the "germ ball" is an embryonal portion of the fatty tissue (Wagner, Meinert), or an ovum (Pagenstecher), or even a "pseud ovum" (Ganine). He affirms that it is a *germ chamber* (an ovarian tube, in fact), and that it gives off a reproductive body (pseud ovum), in accordance with the type of egg formation in insect ovaries generally. The egg-chamber of insects is, however, not, as in the case of these larvæ, *free*, but fixed, and usually forms the terminal portion of an ovarian tube. Leuckart maintains, nevertheless, that the "germ balls" are a true analogue of insect germ chambers, and compares them, in particular, with the germ chambers of *Melophagus*, which are so deeply constructed as to be only united by a thin cord, and therefore almost as independent as the *Cecidomyia* germ balls. This opinion is supported by Leuckart's account of the morphological changes, as observed by him, during the further development of the embryo inside the germ ball or chamber.

As before described, the mature germ ball consists of an enveloping cell lined membrane, the interior space being full of cells derived from the transformed vesicular nuclei. These secondary cells contain nuclei also. After a short time each secondary cell becomes surrounded with granular plasm, which distends the germ ball at one end until it assumes a pyriform shape. The granular mass at the other end differentiates into a substance which quickly transforms itself into a distinct mass, filling up more and more of this interior space, the germ ball becoming oval in shape. At one end (or, pole), there lies embedded in the granular plasm a regular nucleus (germ cell), which does not increase in volume equally with the mass around it. In Ganine's figures this granular mass is distinctly shown, but described as the yolk mass of the pseud ovum. Leuckart, however, comparing the whole with an insect germ chamber, considers the envelope with its cell-lining as corresponding with

the ovarian chamber, the granular mass, together with its included nucleus, as corresponding with the ordinary germinal vesicle, filling one end of the *chamber*, and the remaining cells, together with their surrounding matter, as representing the formative cells of the yolk filling the other part of the chamber.

In the course of subsequent development the lining cells of this envelope disappear, and a line, or layer, of granules is found in their place. The dark, granular mass, with its enclosed nucleus, is the reproductive body (germ egg, or pseud ovum), a germinal membrane being formed over the yolk before it fills the entire chamber. The formative cells of the yolk disappear also as the bulk of the yolk increases, but three or four cells remain at one end of the chamber, and these M. Mecznikoff, who assisted Leuckart in his researches, found to be *not* vitelline cells, but so-called "polar cells," which were finally traced in the young embryo as the rudiment of its germ stock. These polar cells being, therefore, the progeny, by endogamous multiplication, of the original cells lining the chamber, may be supposed to possess the reproductive power, and to be capable of repeating the procreative process when the larvæ containing them have attained to independent life.

With the other naturalists, Leuckart considers this organic larval propagation as essentially identical with that of *Aphis*. The germ stock of *Cecidomyia* he regards as an analogue of the sexual glands, and its filament of connection with the Malpighian vessels as a rudimentary efferent duct. Their germ stock being a sexual apparatus (female only?) the germ ball ranks as an ovarian chamber, and its *contents* constitute the reproductive body (germinal cell and yolk, with residual polar cells which belong to the new germ stock) a sexual apparatus of the larva. The viviparous larvation on this plan is not "gemmaiparous," but true Parthenogenesis, *i.e.* the procreation of germs or pseud ova in an organ of female character, unaccompanied by any fertilising element. None of our authors appear to have observed anything resembling the combination of germ and sperm cells, described by Balbiani as existing in the *Aphis* germ stock. The description given by the latter is, however, so enigmatical as to demand further corroboration.

Leuckart objects to the use of the term ovum, though morphologically undistinguishable in the maturely developed germ chamber, because the larva is an immature animal, and sexless. The word "pseud ovum" he admits as meeting the physiological definition of power possessed by the germ, but remarks that the "alternate generation," in this instance, differs from the usual form, because the sexual individuals which close the cycle of reproduction undergo further metamorphosis before they attain to maturity.

6. Siebold has also published his views respecting this larval propagation, but we have not had any opportunity of studying them. (Kolliker and Siebold's *Zeitschrift*.) But in concluding this historical notice, we must notice the later publications of Dr. Meinert in M. Schrödt's *Natur-historik Zeitschrift*, vol. iii. third series, an abstract of which the author sent to the *Annales des Sciences* (number for July 1866). In the first of the two memoirs, Meinert still maintains that the larval germs are derived from the fatty tissues of the larva. In the second memoir, he enters more particularly into this disputed point, and discusses the whole subject of animal embryogeny. The larvæ discovered by Pagenstecher and Leuckart belong, he says, to species differing from that discovered by Wagner. Having succeeded in this, as in the other case, in obtaining the perfect insect from the larval form, he describes and names it *Oligarces*. He also repeats his opinion that the germs or ova from which the larvæ spring stand in direct connection with and relation to the fatty tissue, maintaining that, in *Miastor*, the germs remain persistently connected with this substance, whilst in *Oligarces*, the germ mass only partially separates from the fatty matter; and that, neither in the one nor the other, is there, as Leuckart insists, any proper "ovary;" for, he observes, the whole mass of germ stock is broken up into germs, and none of the cellules supply any true ovarian stroma, nor form egg-membranes, nor develop into any organs or tissues having analogous functions.

All our authors, however, agree in one point, namely, that the larva germ is essentially a cell-forming material, and partakes of the character usually assigned to female sexual organs. The total absence of any morphological element possessed of a male or fertilising function, seems likewise agreed upon, or may be, at least, negatively inferred. The mode of development is also described by each as essentially an endogenous multiplication of cells, which become either yolk or germ cells, or polar cells, by a process of differentiation, which indicates the highest formative power inherent in reproductive organisms. Even the protoplasm, whether clear or granular, must be viewed as the production of cells previously active, and this organic matter, whether in solid or fluid state, is equally endowed with properties that may be called vital. The self-contained power of evolution, whereby not merely a tissue or part of a body is formed, but the whole assemblage of organs and tissues which constitutes an individual—nay, much more, the future dimorphism of yet undeveloped sexual individuals being included in the effect of this self-contained power of evolution—places the reproductive process in a different category from the repetitive process of growth; and, for this reason, the propagation of larval germs cannot be classed with "gemmiparous reproduction."

A general doctrine of ovology is propounded by Dr. Meinert in his second memoir, which is briefly this:—In mammalia, and most of the invertebrata, the ovum consists of a simple germinal cell, of which the nucleus is the so-called germinal vesicle. This *germinal* cell undergoes segmentation, and is thus multiplied by subdivision into minute *embryonal* cells. A portion of those not required for the formative development of the embryo is reserved for the reproductive organs of the new individual, which contain the respective sperm and germ elements, to be afterwards developed in future generations. In birds, reptiles, fishes, &c., the ovum receives, in addition to the germinal cell, either a number of yolk cells, or a secretion from them constitutes a yolk. These *vitelline cells* do not, like the germinal cell, undergo morphologic development, but pass, without any formative changes, to the *nutritive yolk*. In almost all insects there is, besides, the germinal cell, a vitelline secretion. The residual cells derived from endogeneous multiplication of the germinal cell are, in the insect, the essential part of the tissue, which, by transformation, becomes the fatty substance. Whatever value may be attached to this scheme of ovology, the physiological difficulties of genesis remain still unsolved, and the doctrine of Parthenogenesis remains, as before, a riddle. When Meinert adds to his anatomical scheme the assumption that the influence of a male element is not indispensable—not even necessary—to the development of the germ cell in all those invertebrata characterised by non-sexual propagation, the conclusion may be considered premature, to say the least. The exceptions to a law almost universal are neither so absolutely confirmed, nor so numerous, as to disprove its absolute character. The dimorphism of all creatures (male and female), which seems to be inseparably connected with the law of genesis, is preserved equally in the creatures temporarily multiplying by immature generations. And again, the combination of male and female elements for the production of a new creature, may not be at once obvious, because the types of reproductive organisation may really vary more than we are at present aware of. For instance, forms of hermaphroditism, still more rudimentary than yet observed, might easily be imagined. We are not, therefore, warranted in rejecting the widest application of the known genetic law, because cases occur in which it is masked by the occurrence of special intermediate phases of life, the further study of which may completely confirm and rehabilitate the single and absolute law of genesis.

EXPLANATION OF PLATE VI.

- Fig. 1. Hinder segments of a young larva, showing the fatty matter with "ovary" or "germ stock" imbedded in each lateral mass.
- " 2. Ovary of a larva, 1 mm. long and .17 wide—filament of connection with Malpighian vessels—cellules.
- " 3. Ovary in which commencement of future pseud-ova appear.
- " 4. Ovary containing seven young pseud-ova.
- " 5. A pseud-ovum free—vitellus forming.
- " 6. Do., almost filled with vitellus, the cells reduced in number, and (polar cells) congregated in the clear end.
- " 7. A portion of ovary from which nearly half the pseud-ova have already detached.
- Fig. 1 from Wagner—Figs. 2 to 7 from Ganine—Figs. 8 to 16, Pagenstecher.
- " 8. A larva with large ova, in which the embryonal development is proceeding.
- " 9, 10, 11, 12, 13, 14. Progressive stages of development of ovum up to period of embryonal layer (bourrelet.) The next stages are seen in Fig. 8.
- " 15. An embryo withdrawn from its envelope before maturity. The dorsal portion is bulged by the residual vitellus. The eyes, the armature of spines for locomotion, the adipose mass, the oesophagus and intestinum rectum, with Malpighian vessels, are distinguishable; also the ventral cord and ganglia with supra-oesophageal ganglion.
- " 16. A full-sized larva, with five young larvæ moving freely in its interior. The anterior and posterior extremities of the parent larva are retracted and separated from the exterior chitinous envelope, so that the head of the nymph is seen under the skin of the head of the parent larva.

N.B.—Fig. 5 is not in direct continuation with Fig. 4. It represents the later development of *one* of the "ovules" in Fig. 4.

Fig. 7 represents the ovary containing ovules in different stages of development between that shown in Figs. 4 and 5.

N.B.—The colour is only intended to distinguish the fatty tissues and Malpighian vessels in the diagram, not as the colour of nature.

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ON THE STRUGGLE FOR EXISTENCE AMONGST PLANTS.

By J. D. HOOKER, M.D., F.R.S.

THE quaint dictum, "Plants do not grow where they like best, but where other plants will let them," which is credited to the late eminent horticulturalist, Dean Herbert, of Manchester, expresses a truth not yet half appreciated by botanists. It is a protest against the prevalent belief, that circumstances of climate and soil are the omnipotent regulators of the distribution of vegetables, and that all other considerations are comparatively powerless. The dean's crude axiom has lately found a philosophical exposition and expression, in Mr. Darwin's more celebrated doctrine of the "Struggle for life, and preservation thereby of the favoured races," and if to it we add that great naturalist's more fruitful discovery, of the necessity for insect and other foreign agencies in ensuring fertility, and hence perpetuating the species, we shall find that the powers of climate and soil are reduced to comparatively very narrow limits. Before proceeding to show what are the causes that do materially limit the distribution of species, it may be well to inquire how far the hard-pressed soil and climate theory really helps us to a practical understanding of one or two great questions that fall under our daily observation; of these, the following are the most prominent.

That very similar soils and climates, in different geographical areas, are not inhabited, naturally, either by like species, or like genera;—that very different soils and climates will produce almost equally abundant crops of the same cultivated plants;—and that in the same soil and climate, many hundreds, nay, thousands of species, from other very different soils and climates, may be grown, and propagated, for an indefinite number of successive generations.

Of the first of these statements, the examples embrace some of the best known facts in geographical botany; as, for example, that the Flora of Europe differs wholly from that of temperate North America, South Africa, Australia, and temperate South America, and all these from one another. And that neither soil nor climate is the cause of this difference, is illustrated by the

fact, that thousands of acres in each of these countries are covered, year after year, by crops of the same plant, introduced from one to the other; and by annually increasing numbers of trees, shrubs, and herbs, that have either run wild, or are successfully cultivated in each and all of them. The third proposition follows from the two others, and of this the best example is afforded by a good garden, wherein, on the same soil and under identical conditions, we grow, side by side, plants from very various soils and climates, and ripen their seeds too, provided only that their fertilization is insured. The Cape geraniums, London pride and *Lysimachia nummularia* in our London areas, the pendent American cacti in the cottage windows of Southwark and Lambeth, are even more striking examples of the comparative indifference of many plants to good or bad climate and soil; and what can be more unlike their natural conditions than those to which ferns are exposed in those invaluable contrivances, Ward's cases, in the heart of the city? True, the conditions suit them well, and with respect to humidity, and equability of temperature, are natural to them; but, neither is the absolute temperature, nor the constitution, nor freshness of the air, the same as of the places the ferns are brought from; nor is any systematic attempt made to suit the soil to the species cultivated, for, as Mr. Ward himself well shows, the arctic saxifrage, the English rose, the tropical palm, and desert cactus, live side by side in the same box, and under precisely similar circumstances, and, as it were, in defiance of their natal conditions.

Let it not be supposed that we at all underrate such power as soil and climate really possess. In some cases, as those of chalk, sand, bog, and saline and water plants, soil is very potent; but the number of plants actually dependent on these, or other peculiarities of the soil, is much more limited than is supposed. Of *bond fide* water-plants, there are few amongst phænogams. Sand plants, as a rule, grow equally well on stiffer soils, but are there turned out by more sturdy competitors; and with regard to the calcareous soils, it is their warmth and dryness that fits them, to so great an extent, for many plants that are almost confined to them, or are absolutely peculiar to them. So, too, with regard to temperature, there are limits, as regards heat, cold, and humidity, that species will not overstep and live; but, on the other hand, so much has been done by selection in procuring hardy races of tender plants, and so much may be done by regulating the distribution of earth-temperature, &c., that we already grow tropical plants in the open air during a portion of the year, and eventually may do so for longer periods.

Amongst the most striking examples of apparent indifference to natural conditions of soil and climate, I would especially

adduce two. One is the *Salicornia Arabica*, a plant never found in its natural state, except in most saline situations, but which has flourished for years in the Succulent House at Kew, in a pot full of common soil, to which no salt has ever been added; the other is the tea plant, which luxuriates in the hot humid valleys of Assam, where the thermometer ranges between 70° and 85°, and the atmosphere is so perennially humid, that watches are said to be destroyed after a few months of wear; and it is no less at home in North-Western India, where the summers are as hot and cloudless as any in the world, and the winters very cold. I may add, that the tea plant has survived the intense cold of this last January, at Kew, on the same wall where many hardy and half-hardy plants have been killed.

It is, further, a great mistake to suppose that the native vegetation of a country suffers little and very exceptionally by abnormal seasons. The most conspicuous instance of the contrary that ever fell under my observation, was the destruction of the gigantic gum-tree (*Eucalyptus*) forests, in the central districts of Tasmania, which occurred, if I remember right, about the year 1837. In 1840 I rode over many square miles of country, through stupendous forests, in which every tree was, to all appearance, absolutely lifeless. The district was totally uninhabited, consisting of low mountain ranges, 2,000 feet above the sea, separating marshy tracts interspersed with broad fresh-water lakes. The trees, much like the great gaunt elms in Kensington Gardens during winter, but much larger, were in countless multitudes, 80 to 180 feet high, close-set, and 10 to 20 feet in girth; their weird and ghostly aspect being heightened by the fact of most being charred for a considerable distance up the trunk, the effects of the native practice of firing the grass in summer during the kangaroo hunting season; and by the bark above, hanging from their trunks in streaming shreds, that waved dismally in the wind; for the species was the stringy-bark gum, that sheds its bark after this fashion. And not only had the gum-trees suffered, the hardier *Leptospermum* (tea-tree bush), and many others, were killed, some to the ground, and some altogether; so that though my journey was in spring, and the weather was delightful, the aspect of the vegetation was desolate in the extreme.

In such climates as our own, similar devastations are unknown, and though we know that our island was once covered with other timber than now clothes it, we have every reason to suppose that the change was slow, and the effect either of a gradually altered climate, or of the immigration of trees equally well or better suited to the conditions of the soil and climate, but which had not previously had the opportunity of contesting the ground with the ruling monarchs of the forest.

Making every allowance, then, for the influence of soil and climate in checking the multiplication of individuals, we have still two classes of facts to account for; the one, that plants which succeed so well, when cultivated, that we are assured both soil and climate are favourable to their propagation, nevertheless become immediately or soon extinct when the cultivator's care is withdrawn; the other, that plants of one country, when introduced into another, even with a very different soil and climate, will overrun it, destroy the native vegetation, and prove themselves better suited to local circumstances than the aboriginal plants of the country. In the first case, the reasons are very various, all of them relating to the conditions of the plant's existence. Of these the two most potent are, the absence of fertilising agents, and the destruction of seeds and seedling plants. In the present state of our knowledge it is impossible to say which of these is most fatal in its effect. In the case of our annual plants, or our cereals, which never run wild, it is the latter certainly, for they seed freely enough; in the case of many perennials, shrubs, and trees, it may be the former, as with the common elm and lime, which rarely or never seed in England, though the latter is so notably frequented by insects during its flowering season; whilst a third cause is to be found in their seedling plants being smothered by others, of which we have numerous examples in our common pasture grasses, which are, perhaps, the most prejudicial in this respect. A most conspicuous example of this is afforded by the common maple, of which the seedlings come up early in spring by thousands in the neighbourhood of the parent tree, in lawns and plantations, but scarcely ever survive the smothering effects of the common summer grasses, as soon as these begin to shoot.

When I visited the cedar grove on Mount Lebanon, in the autumn of 1860, I found thousands of seedling plants, but every one of them dead; and so effectual is the annual slaughter of the yearlings in that grove, that, though the seeds are shed in millions, and innumerable seedlings annually spring up, there is not a plant in the grove less than about sixty years old. It may hence have been sixty years since a cedar there survived the first year of its existence; that is to say, has struggled through its infancy, and reached the age even of childhood!

On the other hand, when once the natural conditions of a country have been disturbed, the spread and multiplication of immigrants is so rapid, that it shortly becomes impossible to discover the limits of the old, indigenous Flora. Take the English Flora, for example. If we contrast the cultivated counties with the uncultivated, the difference of their vegetation is so great, that I have often been compelled to doubt whether many of the most familiar so-called wild flowers of the cultivated

counties are indigenous at all; nay, more, I have been tempted to suspect that some of the more variable of them, as some species of *chenopodium* and fumitory, may have originated since cultivation began. In the uncultivated counties, the proportion of annual plants is exceedingly small, whereas, in the cultivated counties, annuals are very numerous; and the further we go from cultivation, roads, and made-ground, the rarer they become, till at last, in the uninhabited islets of the west coast of Scotland, and in its mountainous glens, annuals are extremely rare, and confined to the immediate vicinity of cottages. Let any one who doubts this contrast between the Floras of cultivated and uncultivated regions compare the annuals in such Floræ as those of Suffolk or Essex, the North Riding or Cumberland, with those of the Isle of Wight and the Isle of Arran. And it is not only that annuals abound in the cultivated districts, but that so many are nearly confined to ground that is annually or frequently disturbed. The three commonest of all British plants, for example, are, perhaps, groundsel, shepherd's purse, and *Poa annua*. I do not remember ever having seen any of these plants established where the soil was undisturbed, or where, if undisturbed, they had not been obviously brought by man, or the lower animals; and yet I have gathered one of these, the shepherd's purse, in various parts of Europe, in Syria, in the Himalayas, in Australia, New Zealand, and the Falkland Islands. Were England to be depopulated, I believe that in a very few years these plants, and a large proportion of our common annual "wild flowers," would become exceedingly rare, or extinct, such as the Poppies, Fumitories, Trefoils, Fedias, various species of Speedwell, Anagallis, Cerastiums, Lithospermum, Polygonum, Mallow, Euphorbia, Thlaspi, Senebiera, Medicago, Anthemis, Centaurea, Linaria, Lamium, &c., &c.

It is usually said of some of the above named plants, that they prefer cultivated ground, nitrogenous soil, and so forth; and this is no doubt true, but that they will flourish where no such advantages attend them, a very little observation shows; and that they do not continue to flourish elsewhere is due mainly to the fact that, being annuals, their room is taken as soon as they die, and the next year's seedling has no chance of success in the struggle with perennials.

For good instances of this rapid replacement of annuals by perennials, the new railroad embankments should be examined. Whence the plants come from, which spring up like magic in the cuttings, many feet below the surface of the soil, is a complete mystery, and reminds us of the so-called spontaneous generation of protozoa in newly-made infusions, or in distilled water. In the south of Scotland in 1840-50, and many parts of the north of England, the first plant that made its appearance was *Equisetum*

arvense, which covered the new-formed banks, for miles and miles, with the most lovely green forest of miniature pines. In the following year comparatively few of these were to be seen, and coltsfoot, dandelions, and other biennials, especially Umbelliferæ, with a great number of annuals, presented themselves. For many successive years I had no opportunity of watching the struggle for life on these banks, but when I last saw them they were clothed with perennial grasses, docks, plantains, and other perennial rooted plants.

The destruction of native vegetations by introduced is a subject that has only lately attracted much attention, but it has already assumed an aspect that has startled the most careless observer. Some thirty years ago the fecundity of the horse and European cardoon in the Argentine provinces of South America, so graphically described by Sir Edmund Head, drew the attention of naturalists to the fact, that animals and plants did not necessarily thrive best where found in an indigenous condition; and the spread of the common Dutch clover, *Trifolium repens*, in North America, where it follows the footsteps of man through the pathless forests, has long afforded an equally remarkable instance of vegetable colonisation. Still more recently, in South Africa, Australia, and Tasmania, the Scotch thistle, briar rose, Xanthium, plantains, docks, &c., have all become noxious weeds; and this leads me to the last and most curious point to which I shall allude in this article, viz., that the same annuals and other weeds, that are held so well in check by the indigenous perennial plants of our country, when transplanted to others, show themselves superior to the perennial vegetation of the latter. Of this New Zealand furnishes the most conspicuous example,—it was first visited scarcely more than 100 years ago, and it is not yet fifty since the missionaries first settled in it, and scarce thirty since it received its earliest colonists. The Islands contain about 1,000 species of flowering plants, amongst which no fewer than 180 European weeds have been recorded as intruding themselves, and having become thoroughly naturalised; and probably double that number will yet be found, as they have never been systematically collected; but the most curious part of the history is this, that whereas of indigenous New Zealand plants scarcely any are annual, no less than half the naturalised European ones are annual.

Of the effect of these introduced European plants in destroying the native vegetation, I have given examples in an article that appeared in the *Natural History Review* (January, 1864), from which I quote the following:—

In Australia and New Zealand, the noisy train of English emigration is not more surely doing its work, than the stealthy tide of English weeds, which are creeping over the surface of

the waste, cultivated, and virgin soil, in annually increasing numbers of genera, species and individuals. Apropos of this subject, a correspondent (W. T. Locke Travers, Esq., F.L.S.)—a most active New Zealand botanist—writing from Canterbury, says: “You would be surprised at the rapid spread of European and other foreign plants in this country. All along the sides of the main lines of road through the plains, a *Polygonum* (*aviculare*), called ‘cow-grass,’ grows most luxuriantly, the roots sometimes two feet in depth, and the plants spreading over an area from four to five feet in diameter. The dock (*Rumex obtusifolius* or *R. crispus*) is to be found in every river-bed, extending into the valleys of the mountain-rivers, until these become mere torrents. The sowthistle is spread all over the country, growing luxuriantly nearly up to 6,000 feet. The watercress increases in our still rivers to such an extent as to threaten to choke them altogether; in fact, in the Avon, a still deep stream running through Christ Church, the annual cost of keeping the river free for boat navigation and for purposes of drainage, exceeds 300*l*. I have measured stems twelve feet long and three quarters of an inch in diameter. In some of the mountain districts, where the soil is loose, the white clover is completely displacing the native grasses, forming a close sward. Foreign trees are also very luxuriant in growth. The gum-trees of Australia, the poplars and willows, particularly, grow most rapidly. In fact, the young native vegetation appears to shrink from competition with these more vigorous intruders.”

Dr. Haast, F.L.S., the eminent explorer and geologist, also writes to me as follows:—

“The native (Maori) saying is, ‘as the white man’s rat has driven away the native rat, as the European fly drives away our own, and the clover kills our fern, so will the Maoris disappear before the white man himself.’ It is wonderful to behold the botanical and zoological changes which have taken place since first Captain Cook set foot in New Zealand. Some pigs, which he and other navigators left with the natives, have increased and run wild in such a way that it is impossible to destroy them. There are large tracts of country where they reign supreme. The soil looks as if ploughed by their burrowing. Some station holders of 100,000 acres have had to make contracts for killing them at 6*d*. per tail, and as many as 22,000 on a single run have been killed by adventurous parties without any diminution being discernible. Not only are they obnoxious by occupying the ground which the sheep farmer needs for his flocks, but they assiduously follow the ewes when lambing, and devour the poor lambs as soon as they make their appearance. They do not exist on the western side of the Alps, and only on the lower grounds on the eastern side where snow seldom falls, so that

the explorer has not the advantage of profiting by their existence, where food is scarcest. The boars are sometimes very large, covered with long black bristles, and have enormous tusks, resembling closely the wild boar of the Ardennes, and they are equally savage and courageous.

"Another interesting fact, is the appearance of the Norwegian rat. It has thoroughly extirpated the native rat, and is to be found everywhere, even in the very heart of the Alps, growing to a very large size. The European mouse follows it closely, and, what is more surprising, where it makes its appearance, it drives, in a great degree, the Norway rat away. Amongst other quadrupeds, cattle, dogs, and cats are found in a wild state, but not abundantly.

"The European house-fly is another importation. When it arrives, it repels the blue-bottle of New Zealand, which seems to shun its company. But the spread of the European insect goes on very slowly, so that settlers, knowing its utility, have carried it in boxes and bottles to their new inland stations."

But the most remarkable fact of all has been communicated to me since the above was printed, viz., that the little white clover, and other herbs, are actually strangling and killing outright the New Zealand flax (*Phormium tenax*), a plant of the coarsest, hardest, and toughest description, that forms huge matted patches of woody rhizomes, which send up tufts of sword-like leaves, six to ten feet high, and inconceivably strong in texture and fibre. I know of no English plant to which the New Zealand flax can be likened, so as to give any idea of its robust constitution and habit, to those who do not know it; in some respects the great matted tussocks of *Carex paniculata* approach it. It is difficult enough to imagine the possibility of white clover invading our bogs, and smothering the tussocks of this *Carex*, but this would be child's play in comparison with the resistance the *Phormium* would seem to offer.

The causes of this prepotency of the European weeds are probably many and complicated; one very powerful one is the nature of the New Zealand climate, which favours the duration of life in individuals, and hence gives both perennials and annuals a lengthened growing season, and, in the case of some, more than one seed crop in the year. This is seen in the tendency of mignonette and annual stocks to become biennial and even perennial, in the indigenous form of *Cardamine hirsuta* being perennial, and in the fact that many weeds that seed but once with us, seed during a greater part of the year in New Zealand. Another cause must be sought in the fact, that more of their seeds escape the ravages of birds and insects in New Zealand than in England; the granivorous birds and insects that follow cultivation not having been transported to the Antipodes with the weeds, or, at least, not in proportionate numbers.

Still the fact remains as yet unaccounted for, that annual weeds, which, except for the interference of man, would with us have no chance in the struggle with perennials, in New Zealand have spread in inconceivable quantities into the wildest glens, long before either white men or even their cattle and flocks penetrate to their recesses. Such is the testimony of Drs. Haast and Hector, and Mr. Travers, the original explorers of large areas of different parts of the almost uninhabited middle island, and who have sent to me, as native plants, from hitherto unvisited tracts, British weeds, that were not found in the island by the careful botanists (Banks, Solander, Forster, and Sparrmann) who accompanied Captain Cook in his voyages; and which were not found by the earlier missionaries, but which of late years have abounded on the low lands near every settlement.

This subject of the comparative great *vis-vitæ* of European plants, as compared with those of other countries, involves problems of the highest interest in botanical science, and the subject is as novel as it is interesting; it is quite a virgin one, and requires the calmest and most unprejudiced judgment to treat it well. It cannot be doubted that the progress of civilisation in Europe and Asia has, whilst it has led to the incessant harassing of the soil, led also to the abundant development of a class of plants, annual, biennial, and perennial, which increase more rapidly and obtain a greater development when transplanted to the Southern hemisphere, than they have hitherto done in the Northern, and that, in this respect, they contrast strikingly with the behaviour of plants of the Southern hemisphere when transplanted to the Northern; and hitherto no considerations of climate, soil, or circumstance, have sufficed to explain this phenomenon.

HOW TO STUDY METEOROLOGY.

By G. F. CHAMBERS, F.R.A.S.



THE present paper is designed to meet such remarks as the following: "I am rather interested in Meteorology. I have got plenty of time on my hands. If I knew what to do, and how to do it, I would try and make myself useful to the cause of science." It is believed that the number of persons who devote their energies to the study of Meteorology would be much increased if there were a clear appreciation in the public mind of the fact that a moderate amount of labour, directed into proper channels, would produce results which are as much useful as curious. I lay stress on the word "useful." I wish strenuously to insist, that Meteorology is not a science of mere curiosity, but that on its cultivation depend great questions connected with the public health, agriculture, and navigation.

Meteorology may be sufficiently defined as the study of the weather; practical Meteorology, as a subdivision in which we consider what we are to observe, and how we are to observe, including, of course, the use of instruments. Meteorology differs from most other sciences cultivated in the present day in this respect, that although naturally having different branches, the respective branches can be studied separately and independently, to a greater or less extent, without incongruity. One man, for example, may busy himself with the rainfall of a country; another with its winds, and so on.

I shall avail myself of this circumstance to divide my remarks into sections, not only because that will be, on general grounds, convenient, but also because it will permit the reader, intending to become a working observer, to pick out with facility the particular subject to which he prefers confining his attention.

RAINFALL.—On the whole, this may be pronounced the most important of all meteorological topics. On an excess or a defect in the rainfall of a place depend a variety of things intimately associated with the well-being of the community resident there. Neither is it a trifling matter, that pluviometrical observations require no experience or scientific training; nothing, in fact,

but that methodical common-sense which every fairly educated person is presumed to possess.

A rain-gauge is a contrivance for ascertaining how much rain falls on a particular surface of ground—to what depth it would accumulate if it neither ran away nor soaked in. With any cylindrical vessel and a foot-rule, a *notion* of the quantity of rain that has fallen can be arrived at, but this involves accidental errors, owing to evaporation, and to the difficulty of seeing, to a nicety, how deep the rule has to be plunged into the collected water. Fig. 1 represents a cheap and convenient gauge, known as Howard's. It consists of a metal funnel, the rim of which is accurately turned to a certain diameter (usually five or six inches). The rain, passing through the funnel, is collected in the earthenware receiver. The receiver is emptied once in twenty-four hours, the contents being poured into a graduated glass. The diameter of the glass is so adjusted* to the diameter of the funnel, that a certain vertical height corresponds to a certain depth of fall, and the divisions are marked accordingly. Usually matters are so arranged, that a glass, eight inches high, shall contain half an inch of rain; this permits the divisions, each of the value of $\frac{1}{160}$ th of an inch, to be tolerably far apart.

Another rain-gauge in common use is represented by Fig. 2. It is heavier and more expensive than Howard's, but may be a fixture, inasmuch as the water is drawn off from the tap below, and, by the glass tube, analogous to that used to indicate the quantity of water in a steam boiler, the amount of rain collected can be ascertained by inspection. The employment of this gauge has no other advantage than a slight saving of trouble, an insufficient compensation for the increased cost. A third very common gauge is represented by Fig. 3. It seems scarcely necessary to explain the engraving.

The site selected for a rain-gauge is a matter of some moment—1st, as to elevation: It is well known that, according as a gauge is near the ground, or fifty feet above it, the rain collected will differ by a large amount. One foot above the surface will be found a reasonable height; that clears the splashing from the soil, and as the gauges are usually made about a foot high, its base then rests on the actual ground.—2nd, as to surrounding objects: The gauge must be placed in as open a situation as possible—fifteen or twenty feet away from any wall or shrub—and a greater distance still from a house or tall trees.

There is a diversity of opinion as to whether observations should be made (1) at 9.0 P.M. and entered as belonging to the same day, or (2) at 9.0 A.M. and entered as belonging to

* For the practical object I have now in view, it is needless to say more on this subject.

the day before, or (3) at 9.0 A.M. and entered for the day on which the readings are taken. I adopt (3), believing it to be not only the most rational, but also the most general plan; but at the Greenwich Observatory, they follow (1), whilst the British Meteorological Society recommends (2).

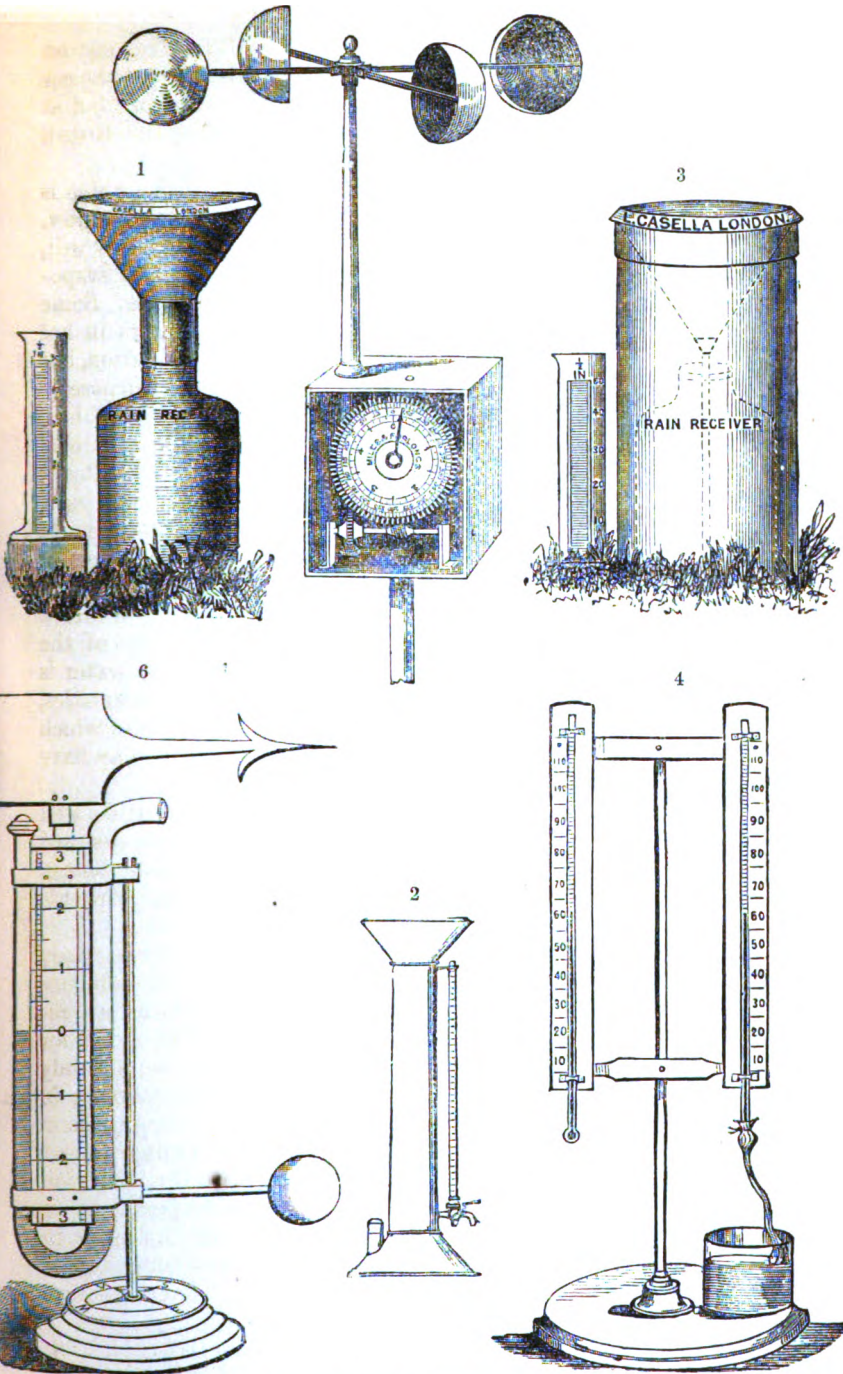
In reading the graduated measure, the level of the water is to be taken to the nearest graduation, whether above or below, giving the benefit of a doubt to the higher one. This will, from month to month, compensate fairly for loss due to evaporation and capillary adhesion to the sides of the receiver. Some observers read oftener than once in twenty-four hours in hot weather, the better to avoid the consequences of evaporation, but I doubt this being necessary, at any rate for general purposes.

Snow is to be melted, and the product treated as rain; but, except when the fall is slight, the rain-gauge must be superseded, or snow may be lost, owing to wind having blown it out of the funnel; and still more, owing to the funnel being incapable of containing any considerable depth of it. The thing to supersede the gauge is a cylindrical tube of the corresponding diameter. Let this be pressed down, in a vertical direction, through the snow, to the ground, and the snow which is forced into it will be the amount from which the measurement of the water should be sought. "The proportion of snow to water is about 17 to 1; and of hail, to water, 8 to 1. These quantities, however, may vary, according to the circumstances under which the snow or hail may have fallen, and the time they may have been on the ground."*

In frosty weather, persons using Howard's gauge will do well to replace the earthenware jar by a glass wine-bottle, inserted in some larger water-tight vessel. If the frost bursts the bottle, the damage done is trifling in pecuniary value, and the contents are saved by the external receptacle.

HYGROMETRY.—Hygrometry is that department of Meteorology which deals with the moisture (scientifically called aqueous vapour) which is present in the atmosphere. Tomlinson's remarks cannot be improved upon:—"The condition of the air as to moisture and dryness is of the greatest importance, not only in the science of the weather but also in domestic economy, in regulating many processes of art, and in directing the purchase and selection of various articles of produce. A good hygrometer will detect the dampness of a room, and indicate the condition of a magazine, a hospital, or sick ward. Some operations in the useful arts require dry rooms, others an air inclining to dampness; some warehouses also require to be dry, others moderately damp, while hot houses, green houses, &c., require

* Tomlinson's *Rain-cloud*, p. 118 (a very useful book).



METEOROLOGICAL INSTRUMENTS.

careful regulation as to moisture. In all such cases the hygrometer is useful, and if used in conjunction with the barometer, storms of rain or wind, whether on shipboard or on land, may be predicted."

Of hygrometers, Daniell's is an elegant instrument, Regnault's elegant and manageable, but Mason's wet and dry bulb (called, by the Germans, the psychrometer) is the one for business purposes. It consists (Fig. 4) of two thermometers, as nearly similar as possible, placed vertically parallel on a stand, and about four inches apart. The bulb of one is covered with thin muslin from which a few threads of lamp or darning cotton hang down; these, passing into a small vessel of water below, keep the muslin and bulb continually moist, and cause this thermometer to indicate a lower temperature than the other one, in proportion to the humidity of the atmosphere, the tendency of objects to dry, or the evaporation going on from surrounding substances. A small difference in the readings indicates the presence of much moisture; but a large difference proves the air to be very dry. The temperature of the dew point can also be arrived at with the aid of this instrument, this temperature being that to which the air must be reduced before the deposition of dew will commence.

In taking an observation, begin with the dry bulb, and be careful always to avoid breathing on or otherwise communicating heat to the instrument. If the temperature of the air be below 32° the wet bulb may read higher than the dry one. Such a reading must not be recorded, but the wet bulb must be moistened, when a coating of ice will form on it, from which evaporation will take place, though an hour or more may elapse before the temperature of the wet bulb has fallen below that of the dry one. If the temperature of the air should rise above 32° , the wet bulb should be carefully immersed in warm water to melt away any ice which may remain on it. The temperature of the water must be less than that up to which the tube is graduated, for if it be greater the expansion of the mercury will burst the tube at the top, for want of a vent.

To discover the dew point we must employ a table framed from an extensive series of comparisons executed at the Royal Observatory, Greenwich, by Mr. Glaisher, who has concluded that this temperature may be ascertained by multiplying the difference between the temperatures of the dry and wet bulb by certain multipliers, and subtracting the product from the temperature of the dry bulb.

GLAISHER'S MULTIPLIERS.

Readings of the Dry Bulb Thermometer.	Multiplier.	Readings of the Dry Bulb Thermometer.	Multiplier.
20	8.1	33	3.0
21	7.9	34	2.8
22	7.6	35	2.6
23	7.3	36	2.5
24	6.9	37-8	2.4
25	6.5	39-41	2.3
26	6.1	42-45	2.2
27	5.6	46-50	2.1
28	5.1	51-56	2.0
29	4.6	57-64	1.9
30	4.2	65-73	1.8
31	3.7	74-86	1.7
32	3.3	87-90	1.6

RULE.—Multiply the difference between the two thermometers by the multiplier corresponding to the temperature of the dry bulb one, and subtract the product from this temperature; then the remainder will be the temperature of the dew point.

EXAMPLE:— Let dry bulb thermometer = 58
 Let wet bulb thermometer = 51
 Difference = 7
 Then $7 \times 1.8 = 13.3$.
 Then, dew point equals $58 - 13.3 = 44.7$

Lieut. Noble has drawn up a table of factors considered to be more accurate than these.

It may be observed, that there are many substances to be met with in nature which are extremely sensitive to variations in the humidity of the atmosphere, and which may be used as *hygrosopes*, such as wood, ivory, quills, hair, whalebone, animal membranes, catgut, &c.

A knowledge of the dew point puts us in the track of much other information connected with atmospheric aqueous vapour, as will be seen from an examination of Glaisher's Tables; but the amateur had better disregard such minutiae, or he will get bewildered.

BAROMETRICAL OBSERVATIONS.—The barometer measures the pressure or density of the atmosphere. The meteorologist will disregard the common notation, 'Fair,' 'Set Fair,' 'Change,' &c. These terms are not only antiquated and nearly obsolete, but are often misleading. In real truth, barometers are best without any remarks of this kind at all; but inasmuch as the public does not

consider simple barometrical tubes, which are merely graduated to inches and decimals, *to be barometers at all*, Admiral Fitzroy's notation should be adopted, if any. What this is, is pretty well known.

Rise for N. Ely.	Fall for S. Wly.
N.W.; N.E.	S.E.; S.W.
Dry, or less wind.	Wet, or more wind.
Except wet from N. Ely.	Except wet from N. Ely.

The more expensive barometers read to thousandths of an inch, but it is submitted that a reading to hundredths is quite sufficient; and that a good working barometer, answering all the reasonable requirements of the amateur, need not cost more than 6*l*.

The due application of the necessary corrections* must not be neglected. These are, for temperature, sea level, and capillarity.

Mercury, like most other substances in nature, expands under the influence of heat and contracts under that of cold. A reading taken when the thermometer stands at 35° may therefore seem to differ from one taken when the thermometer is at 70°, yet the pressure of the atmosphere may be really identical in the two cases. To make the different readings of a series legitimately comparable, they must be brought to some common standard of temperature, and meteorologists are agreed that that shall be 62° of Fahrenheit's thermometer.

It is well known that the barometer is employed for the measurement of heights. What does this imply? Clearly that the elevation of the mercurial column varies as the elevation of the place of observation varies; and such is really the case. An instrument placed 700 feet above the sea may read the same as one placed at the sea level, and yet the real pressure of the atmosphere at the two stations will differ considerably. The sea level is the standard of altitude (*more Hibernicè*) to which it is agreed that all barometrical observations shall be referred. Speaking roughly, every reading has to be augmented by about $\frac{1}{10}$ th of an inch for every 100 feet that the place of observation is elevated above the level of the sea.

The correction for capillarity depends on the well-known property of all liquids to adhere to solid surfaces with which they come in contact. A fictitious level is thus given rise to, or, more accurately, the surface is not level at all, but curvilinear. When mercury is enclosed in a cylindrical tube of small diameter, such as a barometer tube, the surface is convex, and a subtractive correction must be applied to every reading. The

* For tables of these, of course in the present article I have no space. They will be found in various books.

smaller the bore of the tube the greater the correction, hence one advantage of having tubes of large bore, $\frac{3}{4}$ ths of an inch or more.

When great nicety is required there is a fourth correction, namely, that for index error, to be taken into account; but when the instrument is a good one, and is only read to hundredths of an inch, this correction is, or ought to be, too insignificant to demand notice.

The time for taking observations of the barometer is 9 A.M. and 3 P.M., but when two readings a-day cannot be managed, it is best, as it is also most convenient, that the observer should confine himself to the forenoon hour. The height of the metal should be taken as from the summit of the convexity of the curved surface due to capillarity, which is discussed above.

The subject of Weather Prognostications as derivable from the study of the barometer is too large a one to be examined in a paper like the present; but this, however, is the less to be regretted, because Admiral Fitzroy's *Barometer and Weather Guide*, published by the Board of Trade, lays before the reader, in a compact compass and cheap form, all, or nearly all, that can be said on this topic.* As to the Aneroid Barometer, I suppose I ought to say a few words. This instrument is rising in public estimation, and a first-class one is capable of doing good service to the traveller, to whom portability is an essential object; but the stationary observer will not for one moment set it against a mercurial barometer, unless it be for domestic purposes.

TEMPERATURE.—When a sudden extreme of temperature arises, be it of heat or be it of cold, everybody becomes an enthusiastic *thermometrician*, if I may be pardoned for coining such a word. It is to be regretted that this enthusiasm is usually so ephemeral, because the laws of nature, as regards weather and temperatures, though no doubt in one sense obscure, are nevertheless full of interesting coincidences.

To describe such a common instrument as a thermometer seems superfluous; rather let us dwell on the way of using it. The most comprehensive method of determining the annual temperature of a place is by observing daily the maximum and minimum temperature of the air during every complete period of 24 hours, and taking the arithmetical mean of the two readings as the temperature of the day. Thus, let us suppose that on Monday, April 1, 1867, at 9 A.M., the indices of registering thermometers showed that during the previous 24 hours the highest temperature of the air had been 62.5° and the lowest 40.7° . From these data we conclude the mean temperature of the

* This pamphlet does not of course go into the "forecast" system: that is an independent subject—at least the Admiral (who was the best judge) so treated it.

period to have been 51.6° , and the range 21.8° , both of which should be entered in columns of the observer's book provided for the purpose.

Many forms of self-registering thermometers have been contrived, but I deem it unnecessary to speak of more than three here; viz., Sixe's, Rutherford's spirit minimum, and Phillip's mercurial maximum. Sixe's provides for the registration of maximum and minimum temperatures by a single arrangement. It is a handy instrument, and a well-made specimen will give good results to within whole degrees, but it is liable to get out of order, and is expensive of repair. Rutherford's minimum thermometer is a spirit one, with the tube horizontal. The spirit, in sinking by a depression of temperature, draws the index with it, but when a rise occurs the index remains behind, and its end, farthest from the bulb, shows the greatest depression since the previous observation. The instrument is set for further use by a gentle tap, which brings the index to the top of the column of spirit, wherever that may happen to be. In Phillip's maximum thermometer a small portion of the mercury is separated from the bulk by a bubble of air. When the temperature rises, this detached portion is pushed forwards, but when the temperature falls, it does not recede with the main body; consequently it marks the maximum temperature that has occurred since the previous observation.

Concerning simple non-registering thermometers, I need do no more than give some tests for them, using the words of an eminent living physicist and chemist. "When immersed in melting ice, the column of mercury should indicate exactly 32° F.; when suspended with its scale immersed in the steam of water boiling in a metal vessel, the barometer standing at 30 inches [the place of observation being at the level of the sea], the mercury should remain stationary at 212° . When the instrument is inverted, the mercury should fill the tube, and fall with a metallic click, thus showing the perfect exclusion of air. The value of the degrees throughout the tube should be uniform. To ascertain this, a little cylinder of mercury may be detached from the column by a slight jerk, and on inclining the tube it may be made to pass from one portion of the bore to another. If the scale be properly graduated, the column will occupy an equal number of degrees in all parts of the tube."

Thermometers should be hung on a proper stand, facing the north and protected behind and laterally from the direct rays of the sun, yet not so as to impede the free access of air.

Thermometers of a certain sort can be obtained for a shilling, but I need hardly say, these are philosophical toys rather than meteorological instruments. Let the amateur beware of them. A good observatory thermometer costs at least fifteen shillings,

and if it be one of those branded K. O., that is to say, one that has been tested at the Kew Observatory, so much the better. In reading thermometers, care must be taken to avoid the disturbing influence of the heat radiated from the observer's body; that is to say, the observer must approach his instruments, read them as quickly as possible, and retire again, especially taking care to hold his breath.

CLOUDS.—The indications of clouds are, when rightly understood, more important than might be supposed.

Howard first reduced them to an orderly classification, and his nomenclature is now generally accepted. The following is an epitome of it:—

There are three primary forms of cloud and four secondary ones.

Primary Forms.—1. *Cirrus*.—Fibres extensible in various directions: these fibres often resemble feathers, wisps or locks of hair. Generally seen in groups after severe weather, and when the air is in gentle motion. The highest of all clouds.

2. *Cumulus*.—A cloud formed of dense aggregations of convex masses, rising from a horizontal base into irregular mountainous rocky heaps, often with white snowy woolly tops. It characterises dry, fine summer weather. Before rain, it approaches the earth and becomes more dispersed, and the woolly features more prominent.

3. *Stratus*.—An extended continuous stratified aggregation. It forms at sunset, and disappears at sunrise. The lowest of all clouds.

Secondary Forms.—4. *Cirro-Cumulus*.—Cirrus fibres compressed in rounded masses or woolly tufts, disposed, in a measure, horizontally. In warm and dry weather, and especially in summer, it floats at different heights in detached rounded groups.

5. *Cirro-Stratus*.—Cirrus fibres, as if squeezed together by forces operating above and below, which results in a stratification. Solar and lunar halos, mock suns, and mock moons display themselves in clouds of this class.

6. *Cumulo-Stratus*.—Cumulus and stratus clouds intermingled. Large fleecy cumuli rising from or seemingly pierced by stratus clouds. When black or bluish near the horizon, it is passing into—

7. *Nimbus*.—A dense continuous sheet of almost uniform black or grey tint with fringed edges. This is the rain-cloud. The rainbow belongs to it.

Small stray fragments of cloud floating about in the air are termed *scud*. In noting clouds, it is sufficient to designate them by the numbers above, to save space and trouble. Daily records should be taken, if possible about 9 A.M. and 3 P.M., of the

amount of cloud visible, the scale being 0—10. The 0 representing a clear sky, and 10 a sky wholly overcast.

WIND.—Observations on the Wind cannot in general be carried out by amateurs in any very complete manner. Eye observations are rather unsatisfactory, and serviceable mechanical apparatus is necessarily complicated and expensive. For these reasons it will be sufficient to make this a short section.

A wind-vane can be procured from any good ironmonger; the erection of it, however, requires care. The site must be very open, whether the vane be mounted on the top of a pole rising from the ground or on one rising from a building. It must, of course, be correctly "orientated." This must be done by compass, allowance being made for the deviation; and as the whole operation may be a troublesome one, the workmen employed must be closely watched.

Contrivances for registering information as to the wind are called *anemometers*. Robinson's is recommended by Sir H. James, as "simple in its construction, and is not liable to get out of order, whilst it registers the velocity of the wind at any moment, or the current of air passing the station during the hours between the periods of observation.

"It consists (Fig. 5) of arms, at the end of which there are four light hemispherical hollow cups, which, as Dr. Robinson has demonstrated, revolve with one-third of the velocity of the current of wind acting on them. On the vertical axis which carries the arms, there is an endless screw, which communicates its velocity of rotation to a circular index.

"This index has two graduated circles, the outer one of which is graduated for five miles from 0 to 500, and the inner one into five miles, each mile divided into furlongs. The movable hand, from the centre, indicates the number of miles of air in the current which has passed the station, as 5, 10, 15, whilst the final hand indicates the number of odd miles and furlongs (as 3 m. 5 f.) at which the movable hand stands, beyond the five mile graduation. If, for example, the movable hand stands between 15 and 20 on the outer circle, and the final hand indicates 3 m. 5 f., the length of the current 18 m. 5 f.

"The velocity of the wind at any particular moment may be found by observing the index before and after a certain interval of time, as one or five minutes, and then multiplying the rate by 60 or 12 to find the velocity in miles per hour."

The pressure in pounds per square inch can then be ascertained by reference to a table. A milled head-screw, at the back of the instrument, turns the movable index, which should be brought back to zero after an observation is registered. The instrument requires to be erected in some open situation, easily accessible to the observer, but freely exposed to the wind.

Casella, for portability, makes the arms to fold. The instrument can be mounted on a piece of gas pipe or otherwise. Further, it is available for ascertaining the ventilation of places of public resort; an inspection showing at once the progress of the current of air circulating above the heads of an audience.

Lind's anemometer (Fig. 6.) is a portable and elegant little instrument. A column of fluid, descending in a tube of about $\frac{1}{2}$ -inch bore, and ascending one of $\frac{1}{8}$ -inch bore, shows, on a graduated scale, the pressure of the wind on a square foot, and its velocity. A light arrow-shaped vane is placed, when required, upon a point on the upper edge of the instrument, to indicate the coincidence of the mouth-piece with the direction of the wind, and a small plummet line, protected by plate glass in the body of the scale, indicates the true perpendicular position of the instrument.

Other anemometers in use are, Osler's, Whewell's, and Catox's, but, for reasons stated above, they are unsuited to the use of amateurs, and therefore I say nothing about them. In the absence of an anemometer, it is usual to record the force of the wind *guessed*, rather than estimated, by noting it on a scale of 0—10, 0 representing calm, and 10 a terrific hurricane. The progression adopted is usually as follows, but the whole thing is, in the highest degree, vague and unsatisfactory:—

0. Calm.
1. Motion of air hardly felt.
2. Light breeze, just perceptible.
3. Gentle breeze.
4. Brisk pleasant breeze.
5. Very brisk breeze: *fresh*.
6. High wind.
7. Rough squally wind.
8. Very high wind; gale.
9. Hurricane; tempest.
10. Violent hurricane, tearing up trees, &c.

In recording the position of the vane no greater nicety need be attempted than sixteen points of the compass, N., N.N.E., N.E., E.N.E., E., &c.

An observatory, specially fitted up for meteorological purposes, will contain divers instruments, with which the popular observer has no special concern, such as the electrometer, the actinometer, the cyanometer, the evaporating gauge, the ozonometer, &c. For information on points connected with these, reference must be made to treatises on meteorology, of which, by the way, there is a great dearth. The ordinary amateur will

find his time and energies sufficiently taxed by working at the subjects I have dealt with, I fear, very imperfectly, in the foregoing pages. Far better is it to take up and stick to a few things, than to attempt everything and break down in a few months.*

* For the Illustrations in this article I am indebted to Mr. Casella, of Hatton Garden.

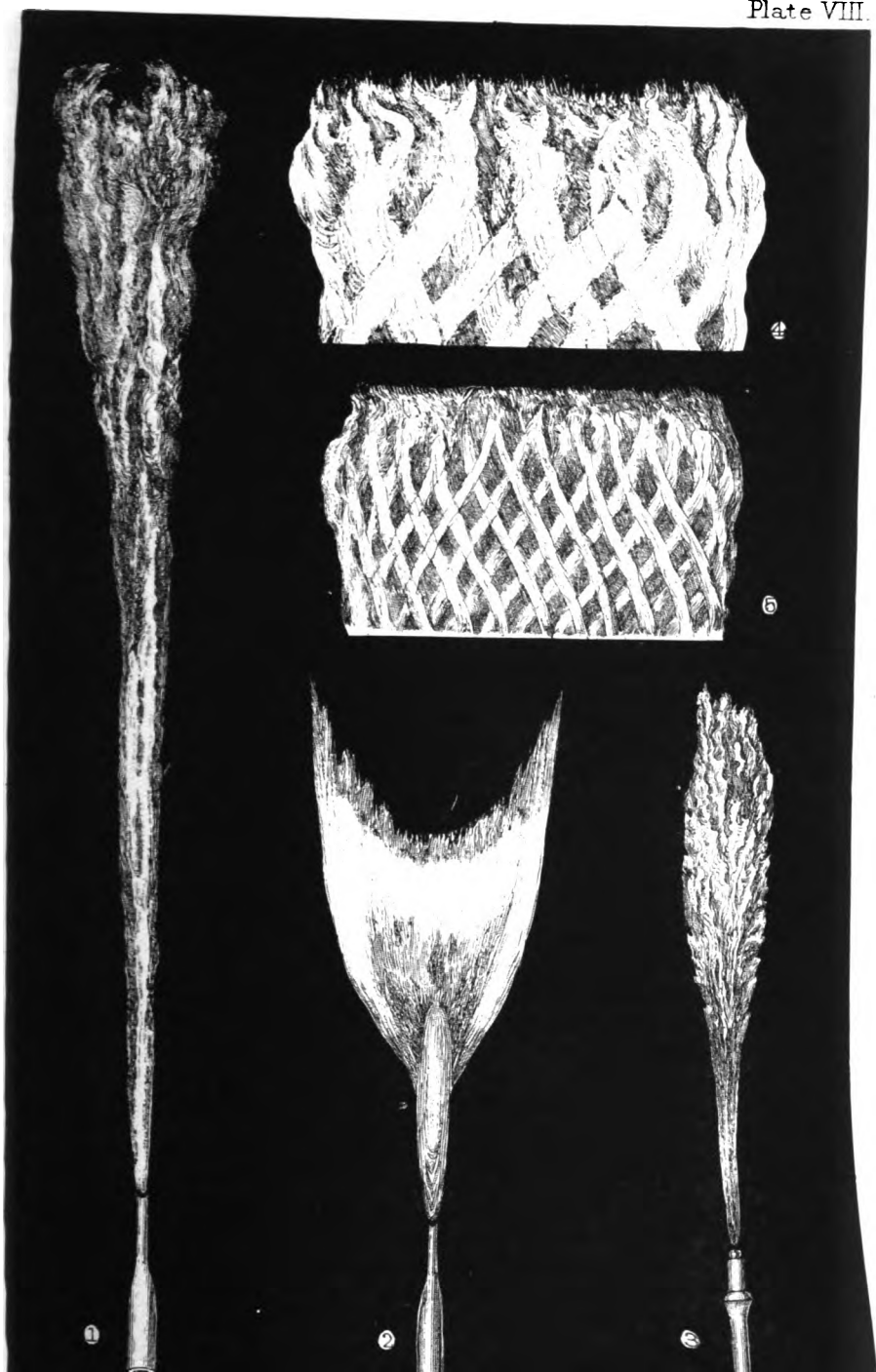
ON SENSITIVE FLAMES.

By W. F. BARRETT,

Lecturer on Natural Science at the International College.

SENSITIVE flames, as they have appropriately been called, are flames which, by their sudden movement at the slightest sound, evince a wondrous susceptibility to the influence of sonorous vibrations. The story of their discovery is briefly this. In the year 1865, whilst engaged in the preparation of the experiments for the Christmas lectures at the Royal Institution, the writer of this article observed that a shrill and prolonged sound had a curious effect on a tall and slender gas-flame which happened to be burning near. Under the influence of the sound the flame, which was about 14 inches long, shortened itself several inches; at the same time the upper part spread out sideways into a flat flame, which gave an increased amount of light from the more perfect combustion of the gas. Less strongly, the same effect took place when a high note was uttered or played even so far off as 30 or 40 feet away. So strange an occurrence could not be permitted to pass without further investigation; as soon as possible, therefore, I submitted the observation to a brief examination, in which I succeeded in finding some of the conditions of success of this singular phenomenon, and so exalting the action that the flame moved at every noise. The results of this inquiry I showed to Professor Tyndall in the early part of last year, and did not then make any further publication of the matter.

I next sought to ascertain if the effect had been previously noticed, but could discover no published account of a similar experiment. I learnt, however, that mechanics sometimes observe the large bat's-wing gas-flames in their workshops to become disturbed, and throw out little tongues of flame, when the noise of their work happens to be sustained and shrill. I next heard, through Professor Tyndall, that an American gentleman, Dr. Leconte, had noticed and published an account of an analogous effect to this last, but not until recently did I read the following extract from his paper on the subject. After re-



marking that he was at an evening party in which there was a performance on musical instruments, and that the room was lighted by the so-called fish-tail gas flames, Dr. Leconte says:—"Soon after the music commenced, I observed that the flame of the burner exhibited pulsations in height which were exactly synchronous with the audible beats. This phenomenon was very striking to every one in the room, and especially so when the strong notes of the violoncello came in. It was exceedingly interesting to observe how perfectly even the trills of this instrument were reflected on the sheet of flame. A deaf man might have seen the harmony. As the evening advanced, and the diminished consumption of gas in the city increased the pressure, the phenomenon became more conspicuous. The jumping of the flame gradually increased, became somewhat irregular, and finally it began to flare continuously, emitting the characteristic sound indicating the escape of a greater amount of gas than could be properly consumed. I then ascertained, by experiment, that the phenomenon did not take place unless the discharge of gas was so regulated that the flame approximated to flaring. I likewise determined that the effects were not produced by jarring or shaking the floor and walls of the room by means of repeated concussions. Hence it is obvious that the pulsations of the flame were not owing to indirect vibrations propagated through the medium of the walls of the room to the burning apparatus, but must have been produced by the direct influence of aërial sonorous pulses on the burning jet."

The paper from which this extract is taken was published in Silliman's *American Journal* for January 1858, and in the *Philosophical Magazine* for March 1858; but though thus announced nine years ago in America and England, Dr. Leconte's observation does not appear to be generally known in either country. It will be noticed that it is the converse of mine; differing from it, however, in some respects. Thus, as regards change of appearance and the amount of visible motion, the shrinking of the tall flame far exceeds the spasmodic jumping of the fish-tail: and further, although at first both flames were only affected by the prolonged action of a musical sound, yet subsequently the upright flame was caused to shrink at any noise; whilst Dr. Leconte remarks the fish-tail flame was uninfluenced by noises of any kind, but always required the energetic and sustained vibration of a musical note. Dr. Leconte, however, made the happy and important observation, that his flame did not jump until the pressure of the gas caused it to be near flaring. This, as will be seen in the sequel, is the key-note to the whole phenomena.

Professor Tyndall next took up the subject, and increasing the

pressure of the gas, as indicated by the American physicist, enriched the experiments and brought the subject so under command as to raise them to the dignity of a Friday evening lecture at the Royal Institution. It was in this elegant lecture demonstration of January 18th last, that Dr. Tyndall gave at once the name and publicity to "Sensitive Flames."

So much for the historical part of the subject. Let us now describe more in detail how gas flames may be rendered sensitive, and what they are capable of exhibiting when in this state.

In my investigation of the shrinking flame the gas was used direct from the main. The flame burnt, therefore, under the ordinary pressure attainable by everyone. The most essential condition of success is the shape of the burner whence the gas issues. The one I found to succeed the best is shown in the annexed drawing, fig. 1, where it is represented of its real size.



It is formed of a piece of glass tubing, about $\frac{3}{8}$ ths of an inch across, contracted at one end to a tapering orifice $\frac{1}{16}$ th of an inch in diameter. This orifice must be slightly v-shaped, as shown in the figure. It is only the work of a minute to form such a burner. A short length of glass tubing, softened in a gas flame, is readily drawn out to a point, the extreme end of which must be broken off; and the aperture can then be enlarged, and snipped into the shape indicated by means of a pair of scissors. Connecting this burner with the gas pipes, by means of some flexible tubing, it should be continually tested with the sound of a whistle whilst it is being trimmed into shape. I have always found this rough and ready mode of making the burner to answer very well. A more permanent burner can also be formed of a gas-fitter's brass blowpipe, straightened and filed to a rather larger and v-shaped aperture; or it

Fig. 1. may be made of a bit of compo gas piping hammered at one end into a tapering orifice. A little patience and experience will soon bring success, of whatever material the burner be made.

When any one of these properly shaped burners is connected with the gas pipes, the stopcock being fully open, a tapering flame about 15 inches long is obtained. The sound of a whistle, or the higher notes of a musical instrument, or even a noise, as clapping the hands or tapping the table, totally alters the shape and character of this flame. Immediately the sound is made, the tall quivering flame shrinks down nearly half its height, and spreading out laterally into a fish-tail flame, gives a largely increased amount of light, from its better exposure to the air. On the cessation of the sound, the flame again rises to its original height. The difference between the two flames is shown

in Plate VIII. Fig. 1 is the tall flame, with its dull, smoky, unsteady appearance, and its loose, ill-defined shape. Fig. 2 is the same flame under the influence of sonorous vibrations; it has fallen a height of six to nine inches, and widened out some three inches; the half-burnt gas, the clouds of carbon, the lack of definition have gone, and all this wondrous change has been brought about by the influence of a little noise.*

Some amusing experiments, dependent on this change in the luminosity and shape of the flame, at once suggest themselves. One may retire to such a distance from the flame that small print shall be illegible, but, by whistling, the flame may be made to diverge, and as long as you whistle you can see to read. Still more effective for lecture illustration is the following. When the flame is burning upright, any combustible substance, as matches, gunpowder, gun-cotton, or a strip of paper, may be placed about an inch from the middle of the flame. A stroke on the c above the treble of a piano, a whistle, or a clap, will at once diverge the flame and ignite the neighbouring substances.

This remarkable change in the aspect of the flame is wrought solely by the effect of sonorous vibrations, and is not at all due to the impact of the puffs of air which may have attended the production of the sound. Nothing material has been translated to the flame. The particles of air, if ever so violently displaced, could not struggle onward, even for a short distance, through the entangled barrier produced by their surrounding neighbours; and, could they reach the flame, their impact would be incompetent to produce an effect so strange and sure. It is solely the wave-like, to-and-fro motion of the air, by which sound is propagated from place to place, that has caused this change. It is the product of translated *motion*, not of translated *matter*. But any lingering doubt as to the possibility of some tangible connection with the flame will speedily disappear. Let a person go whistling out of the room in which is the sensitive flame, and let the door and every opening be closed after him. If he continue to whistle, the flame will still respond, though with enfeebled power as the distance increases and obstacles arise in the path of the sonorous waves. Still let your friend go on whistling, as he retreats into some upstairs room two or three stories away. The flame, if properly sensitive, will be visibly affected every time the faint sound of the whistle is heard. The velocity with which sound is propagated is here well illustrated, the movement of the flame being simultaneous with the hearing of the sound.

* For the representation of these flames and the other drawings on the plate, I am indebted to the skill of my friend Mr. Hedman.

It is very wonderful to reflect, how almost infinitely small is the amount of vibratory motion here rendered evident by our sensitive flame. The molecular motion of the air excited by a sound does not diminish merely in proportion as the distance increases, but far more rapidly: it is inversely proportional to the square of the distance. Remembering this, and that a decided action upon the flame was produced by no very loud sound, made at a distance of thirty or forty feet away, we are startled at the smallness of the motion capable of producing so sensible an effect. Further, when we add to the diminution by distance, the great enfeeblement of the motion of the sound waves in overcoming the solid obstacles that intervened between them and the flame, the result is still more amazing, and, were it not attended with the certainty of a natural fact, one would be inclined to doubt its truth.

A sensitive flame, such as here described, can be applied to many purposes of experimental illustration. For instance, it may be used to indicate the fact that, a body, when sounding, divides itself into vibrating segments, separated by intervals of rest. This is usually shown by the unequal disturbance of some solid, placed on the vibrating body; but, for an audience, who cannot look down on the lecture table, this method is open to objection. A gas flame, which need not be very sensitive, can then be used with advantage. If, for example, a large brass plate, fixed at its centre, be thrown into vibration by means of a fiddle-bow, a strained and intense divergence of the flame is obtained, when the higher notes of the plate are sounded. Holding the plate thus sounding, close to and parallel with the flame, and moving it slowly, so as to bring different parts in succession opposite the flame, the principal nodal lines can be traced as easily as with sand. The intervals of rest in the vibrating plate allow the flame to raise itself up, and, in its sluggish combustion, to stand, as it were, at ease, whilst the ventral segments drag it down to active burning and soldierly attention. Again, the so-called *beats*, produced by the interference of nearly unisont sounds, can be rendered more apparent by the movement of the flame. Striking, with a fiddle-bow, a large bell, or the brass plate above mentioned, these beats, though but faintly audible, cause evident changes in the flame. At every beat, the momentary silence allows the flame partially to regain its original height, from which, however, it is almost immediately thrown down by the sound which follows, erecting itself at the next beat, only to be thrust back as the sound again wells up. Thus, a sort of breathing flame is produced, the aspirations of which are strictly timed to the sighing of the bell.

But it is not to every sound that the flame is equally sensi-

tive. However loud a note may be, if below a certain pitch, it will have no effect on the flame. This influence of pitch is well illustrated by running up the scale of a piano-forte; the bass notes do not disturb the flame in the slightest; but, as the high notes are approached, the flame becomes uneasy, and at last diverges strongly, when the third octave in the treble is reached. The strings in this octave make from 2,000 to 4,000 vibrations a second. Moreover, the note which exercises the most influence on the flame, is not the same for all burners. I have in my possession a series of glass burners, each of which gives sensitive flames; the orifices are of different sizes, and the flames are variously influenced by whistling the notes of the gamut. It appears that the smaller the orifice in the burner, the higher is the pitch of that note which most powerfully affects the flame. And, I have no doubt that, by means of a large and proper orifice and low pressure, a flame might be made responsive to grave sounds.

With differently shaped burners effects complementary to those previously described have been obtained. Thus, the original flame may be of a fish-tail appearance, like fig. 2 in the plate. At the sound of a whistle, the flame rises into the tall, smoky flame shown in fig. 1, sinking back into the forked and flat shape the moment the sound ceases. It was an incipient effect of this kind that was noticed by Dr. Leconte in his fish-tail burner. With a large sized batwing burner the phenomenon is rendered more striking. The beautiful sheet of flame which this burner gives is split up into numerous tongues, at the sound of a whistle. This change is represented in fig. 2: *a* is the

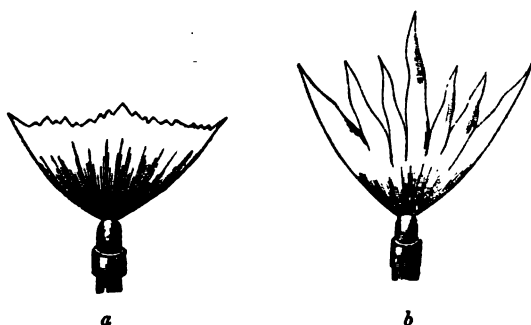


Fig. 2.

quiescent flame, *b* the same flame, under the influence of the sound, thrusting out its fiery fingers.*

* This experiment is Dr. Tyndall's, to whose kindness I am indebted for the drawing from which this cut is taken, it being one of the illustrations in his forthcoming book on "Sound." To that work the reader is referred

Except this last experiment, which requires an additional pressure on the gas, all the foregoing experiments can be repeated merely by attention to the shape and size of the burner, having the stopcocks and gas passages as widely open and free as possible, and using the gas under the greatest pressure obtainable from the main; hence the dusk of the evening, when this pressure appears to be at its maximum, is the best time for repeating these experiments. The same burner may give a flame not sensitive at one time of the day, but very sensitive at another, and the pressure may become so great that the flame may again lose its sensitiveness. Other burners, as the batswing, require a greater pressure than that which is given from the gas works to make them sensitive.

To obtain, therefore, the most complete results we must ourselves increase the pressure of the gas. This can be done by filling a gas-holder or gas-bag with coal-gas, and forcing the gas therefrom; or, lacking these, a useful substitute can be found in an india rubber air pillow, which must have its screw replaced by a stopcock. Through a flexible tube the gas can be conducted from its reservoir to the burner, which may be held fast in a clip, or other support. All that is now necessary is to bring the gas very near to the point at which it gives a roaring noise as it issues from the burner. This is accomplished by altering the weights on the bag, or adjusting the stopcock of the holder. The general arrangement of the apparatus is shown in Fig. 3.

Under this increased pressure other burners can be used beside the shape shown in fig. 1. A circular iron nipple can be employed, or still better, a burner made of steatite or silicate of magnesia, a substance which has the advantage of expanding so slightly by heat, and being uncorroded by use, that practically the size of the orifice remains always the same. Selecting one of these steatite burners having a single circular orifice, .046 inch in diameter, or just admitting No. 19 wire, and igniting the gas which is urged from it, a

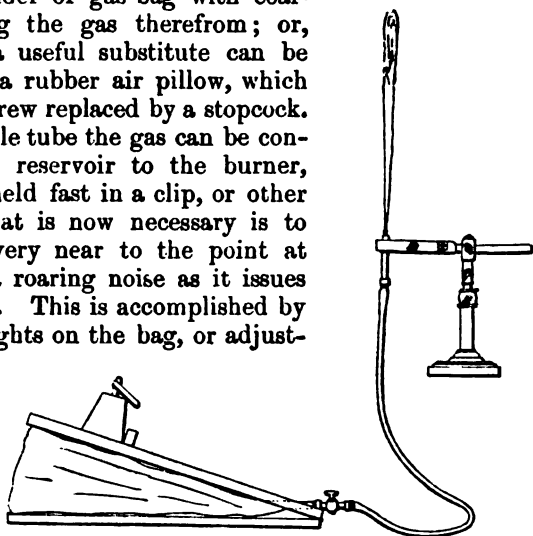


Fig. 3.

for further information, and, I need hardly add, what is sure to be the most lucid exposition of the subject of "Sensitive Flames."

sensitive flame is obtained of a new character, and of extraordinary susceptibility to certain sounds.*

Uninfluenced by sound this flame can be made to attain a height of full twenty inches, burning with greater steadiness and less smoke than that shown in Plate VIII. fig. 1, but having the same long and tapering character as the flame there drawn. The effect of sound on this flame reduces it to a very different shape from that of fig. 2 on the plate; at the noise of a tap it shrinks down half its height, or nearly a foot, the upper part becomes thick and bushy, the lower remains unchanged; and, instead of burning more steadily and with a better light under the influence of sound, it becomes tumultuous and less luminous. In this state it is shown at fig. 3 on the plate, having, it will be noticed, irregular little coruscations clinging and flickering up its sides. We will call fig. 2 the *divergent*, and this, fig. 3, the *brush* flame. It is a wonderfully delicate flame. Like a sensitive, nervous person, it starts and shrinks at every little noise; the change in its aspect being so great as to cause it to be one of the most striking and effective of all the sensitive flames. But, most curious of all, this flame is especially sensitive to the letter S, or any sibilant sound. Tell it to appear as a "brush," and it instantly obeys, vigorously assuming its characteristic shape, shown in fig. 3. Say to it "hush," and at once, with a spiteful, fluttering noise, it cowers down nine inches. A whisper, too, being rich in sibilants, is at once detected by the flame, which crouches, as if to listen, the moment you move your lips. Like most sensitive people, it keenly feels the effect of a "hiss." Let it hear you make such a sound, and it drops from its lofty height, shrinking into a foolish, fussy little flame, which, as though in agony, fairly begins to roar if you venture to sustain that disparaging sound. Even if you go far away and out of sight, the flame will shiver all over every time you utter the obnoxious sibilant.†

But this flame, like the others, is not at all sensitive to some

* This flame was first noticed by Dr. Tyndall, and the associated experiments shown by him at the Friday evening lecture to which reference has been made. To obtain the flame it is not at all essential that the burner should be of steatite, but it will be noticed that the orifice is smaller than that of the burner previously described.

† In a note attached to a paper on sensitive flames, published in the March number of the *Philosophical Magazine*, I have drawn attention to other remarkable peculiarities which are associated with the sound of the letter S. I have frequently noticed that when any sibilant is uttered simultaneously by a large assemblage of people, the resulting sound is far different in intensity to that of any other—a striking noise being produced, like the escape of steam from a high-pressure boiler. It is worthy of remark that the Astronomer Royal believes the sound of the letters S or Z to be produced in a manner different from the rest; namely, by an interruption in the continuity of the particles of air.

sounds; it is only the high notes which affect it. If the strings of a violin be struck, the grave notes produce no alteration, whilst the highest ones violently urge it down. Hence, if a tune be played on a musical instrument, the flame, variously affected by the different notes, dances in perfect time to the music. Still more striking is this action when a musical snuff-box is set going, and placed near the flame. Indeed, so very magical is the unseen connection between the instrument and the flame, that at first sight the experiment seems more appropriate for a conjuror's stage than a scientific lecture table: but are not the experiments of the philosopher always more wonderful than the tricks of the conjuror?

In the same way that the flame responds to certain notes of musical instruments, so it picks out, and is more or less moved by various vocal sounds. Repeating, in the same pitch, the vowels to the flame, it will be seen that the sound of *u* cannot stir the flame, whilst *e* affects it powerfully, and *ah* still more energetically. The cause of this is found in the fact, that in the latter sounds there are present higher tones which are absent in the first, and it is to these over-tones, or harmonics, of the fundamental note common to all the vowel sounds, that the agitation of the flame was due. If, therefore, we address the flame, it curtsies, bobs, and bows, or remains unmoved, just as the words we utter may happen to contain more or less, or none of those high notes, to which this flame is peculiarly sensitive.

Hence the reason why the flame is so intensely agitated by a noise. For this unmusical sound is caused by an admixture of various notes, and among them, especially if the noise be of a certain class, are sure to be found a few of those notes which most largely influence the flame. The sound of the gentlest tap, the chinking of money, the creaking of boots, the crackling of a fire, the dropping of a cinder, and even the splashing of a rain drop and the ticking of a watch, all startle or convulse the flame. Whilst the crumpling of tracing paper, or the rustling of a silk dress, sets it frantic with commotion.

What, let us now ask, is the explanation of these remarkable phenomena? Seeking to know the cause of what I had observed, I was led to notice last summer, that an increased pressure of the gas acted precisely like a shrill sound in shortening the flame. Dr. Leconte has, however, the prior claim to this observation, which has been raised by Professor Tyndall to an explanation of the phenomenon, given in the following words:—"The gas issues from its burner with a hiss, and an external sound of this character added to that of a gas-jet already on the point of roaring, is equivalent to an augmentation of pressure on the issuing stream of gas."* This statement holds good for all

* *Philosophical Magazine*, February 1867, p. 99.

kinds of sensitive flames. They all stand, as Professor Tyndall puts it, on the brink of a precipice, over which the sound pushes them. If the pressure be increased, they shorten and roar, and the sound has the same effect: "The sonorous pulses, in fact, furnish the supplement of energy necessary to produce the roar and shorten the flame."

Some may object to this explanation, on the ground that it is inconceivable so small an amount of wave motion as in some cases reaches the flame could sensibly affect the pressure of the gas. Though this does seem a difficulty, still the amount of increased pressure necessary to make a gas-flame roar, when it is on the point of doing so, is wonderfully small. I have been informed by Mr. Sugg, the gas engineer, that an increase of pressure equal to the depression of a column of water through the space of only the hundredth of an inch can cause the flaring of a fish-tail gas-flame. Through the kindness of the same gentleman I have been able to determine the point at which a flame becomes sensitive under increased pressure. With a steatite burner just admitting No. 19 wire, the flame was sensitive at pressure of a $2\frac{1}{2}$ inches of water, but was at its best, and on the point of roaring, at $3\frac{1}{2}$ inches. With a smaller sized burner, admitting No. 21 wire, the flame began to be sensitive at 5 inches pressure, and was at its best at 6 inches. Further increase of pressure, in either case, caused the flame to shrink, and take precisely the appearance it has when under the influence of sound, as in fig. 3 on the plate.*

It must, however, be acknowledged, that the explanation just given does not clear up the difficulty, for as yet its distinguished author has not shown *how* an external sound can produce an effect equivalent to an augmentation of pressure. Moreover, it does not, I apprehend, account for the fact that only notes of a certain pitch affect one flame, nor why different notes influence different flames.

Further light seems to be thrown on the matter by a critical examination of the flame in its various states. To accomplish this, we must exalt the sensibility of our vision by adopting

* The gas here used was cannel, but the quality of the gas will doubtless greatly influence the result. Issuing from the same orifice, and under the same pressure, cannel gas gives a far higher flame than the common coal gas. Indeed, this difference in the height of the flame is the principle of what is known as the jet photometer. This instrument consists merely of a jet of gas, issuing from one of these steatite burners, burning in front of a graduated scale. A very slight change in the illuminants contained in the gas causes a marked alteration in the height of the flame. If the flame happens to be near flaring, it is evident that shrill sounds should be avoided during the observations of such a photometer: in fact, the burner which at the least pressure gave me the most sensitive flame was the very one which had been discarded from photometric use on account of the irregularity of its indications.

the ingenious suggestion of Mr. Wheatstone, which consists in causing the image of the flame to travel over different parts of the retina, by looking at the reflection in a moving mirror. Examined in this way, a steady jet of gas gives an uninterrupted band of light, like a glowing stick whirled in the air, but the continuity is broken when the flame begins to roar, for then a number of images are seen with dark spaces in between.*

In this case the flame is nearly blown out by the rush of gas, but rekindled before it is quite extinguished, and this alternate action, rapidly kept up, constitutes the flicker of a candle and the roar of a gas flame. When roaring, therefore, a flame is in a state of rapid vibration, and it is this vibration which produces the succession of images seen in a moving mirror.

Now, imagine a sound to be made in a room wherein a steady jet of gas is burning; the flame, along with other things in the room, is thrown into a state of vibration corresponding with the sound. The flame, being most easily disturbed, will be the most agitated, but will not be perceptibly affected, unless it be near its sensitive point. Now, permit an increased flow of gas to issue from the burner, so that the flame shall be just at its sensitive point, that is, if the gas ripples a little faster through the orifice the flame will change its shape and be thrown into a state of vibration. Let a sound be again made—if the vibrations now excited in the flame happen to be synchronous with those which the flame only lacked, in order to make it roar, then, those vibrations being superinduced by an extraneous source, the flame will accompany its response to the sound by a change in its shape. Hence, a sensitive flame is the analogue of a resonant column of air; both are caused insensibly to vibrate at any note, but when the pitch of the note accords with the normal rate of vibration of the flame or the air, then the flame visibly, and the column of air audibly, responds with energy to that note. So that bringing the flame to the point at which it is sensitive to a particular note, is like adjusting the length of a column of air until it resounds to a certain tuning-fork.

That a sensitive flame, under the influence of sound, is in a state of rapid vibration can readily be proved. Thus, the flames shown at fig. 2 and fig. 3 on the plate, when regarded in a moving mirror, are seen to consist of a succession of flames,

* By varying the motion of the mirror, this effect can be rendered very beautiful, and nothing is simpler to reproduce. A bit of looking-glass twisted to and fro in the hand before a flickering candle, or a roaring gas-flame resolves these common objects into luminous chains and crowns of weird and matchless beauty. It is indeed surprising, how we neglect the beauty which is so lavishly scattered through the great treasure-house of nature.

giving the appearance shown in fig. 4. The crossing of the images is due to the to-and-fro motion of the mirror. The isochronous vibration of the flame that is here revealed, gives rise to a musical note in the case of the divergent flame.

But whilst a sensitive flame is most affected by sounds of a definite pitch, it can also respond to a certain range of vibrations, so that within limits the higher the pitch of the exciting sound, the more rapid the vibration of the flame. A fine experiment illustrating this fact can be made by sounding a musical instrument near the divergent flame, at the same time looking at its reflection in a moving mirror. With a comparatively low note, the images of the flame stand widely apart, as shown in the plate at fig. 4. Raising the pitch of the note, the flame vibrates more rapidly, the images seen in the mirror become more numerous, and link themselves into a reticulated pattern of exquisite beauty. This is shown in fig. 5, but in both cases the representation falls far short of the beauty of the real appearance. As the note rises still higher in pitch, the network becomes finer and finer, until the eye can no longer separate the images in the mirror. The value of a flame in searching the condition of a vibrating body can here be seen, for in the moving mirror it is easy to detect the frequent admixture of higher notes with the fundamental tone. At such times small and numerous images of the flame are observed to ride on the backs of the large and widely-separated ones. By means of a concave mirror moved to-and-fro, this effect can easily be thrown on a screen, and many points in acoustics may, in this way, be demonstrated in the simplest manner.

Thus have we sought to translate the phenomena of these sensitive flames from the "disorderly mystery of ignorance" into the "orderly mystery of science." For, notwithstanding any explanation which may be given, the facts remain as wonderful and mysterious as ever. And science does not remove this mystery, does not lessen this wonder: it teaches us that we are surrounded by wonders, that we are enveloped in mystery; and, at present, it can do but little more than reveal these wonders, classify these mysterious facts, and awaken a right and intelligent appreciation of them.

March 11th, 1867.

P.S.—Whilst these sheets were passing through the press, subsequent experiments and further consideration have led me to supplement and to simplify the explanation given in this article. It has been shown, that a sensitive flame is one which, on the slightest mechanical increase in the pressure, or, what comes to the same thing, in the *velocity* of the gas as it issues

from the burner, will change its shape, and take precisely the appearance it has when influenced by sound. Now, the sonorous pulses, excited by a sound, throw the pipe which conveys the gas to the burner into vibration, the flow of gas is thereby urged from the sides towards the centre of the tube, and, being confined within narrower limits, issues from the burner with an increased velocity, so long as the sound continues. This, I believe, is the simple philosophy of *how* sonorous vibrations can effect an increase in the pressure of the gas; and, it needs but a little reflection, to see the ready explanation it affords to every difficulty, e.g., the importance of freedom in the gas-passages, the superior effect of high notes, and the fact that the nearer the gas is to the point at which its velocity through the burner will cause an alteration in the shape of the flame, the less sustained and the less loud need be the sound which precipitates this change.

March 20th.

PARAFFIN LAMPS AND THEIR DANGERS.

By JOHN ATTFIELD, Ph.D., F.C.S.

THE oil in a paraffin lamp, as in most other oil-lamps of simple construction, passes up a wick by capillary attraction, comes in contact with the brasswork of the lamp in the long slit or channel which holds the wick, and finally burns at the top of the wick, by help of a strong current of air. The flame heats the metal in its vicinity, the heat is conducted downwards to all parts of the brasswork, and thus every drop of oil that flows up the wick becomes heated to a temperature of 105 to 110 degrees of Fahrenheit's thermometer the moment it touches the metallic slit. According to the quality of the oil, this temperature is or is not sufficient to convert a portion of the oil into vapour. If the oil is badly refined, the warm metal causes evolution of vapour, which mixes at once with the air in the upper part of the reservoir of the lamp; at once, because the portion of the brasswork that is at the above temperature is just that portion which faces the interior of the reservoir of the lamp. This vapour accumulates in the confined air, and the mixture soon reaches proportions in which it is inflammable. Should the mixture now catch light, the resulting flame and expanded products of combustion, having no other vent, will escape by bursting the reservoir, scattering the oil all around. The result is, of course, fright to those who witness the accident, and risk of a conflagration, should the escaping oil happen to ignite.

The chances against an explosive mixture forming in a lamp are, at the present time, unfortunately, very small; for nine-tenths of the light-coloured American oils met with in the shops under various names generate the mixture as soon as they are warmed up to 80 or 90 degrees. It is here only fair to say that I have not met with a specimen of Young's oil which gives off inflammable vapour below 130 degrees; I have, however, met with samples which were, apparently, mixtures of English and Ameri-

can oil, and these gave me explosions in an experimental lamp. The American oils could be rendered non-explosive just as easily as Young's, but it is against the interest of 'the trade' to do this. It is true there is an Act of Parliament, which came into operation in October, 1862, forbidding the warehousing of much more than one barrel of American oil, unless proof is forthcoming that it gives off no inflammable vapour, below 100 degrees; but merchants, brokers, and dealers in the oil consider these words to mean that the oil itself shall not ignite under 100 degrees, when a lighted match is dipped into it, which is really a very different thing. For oil that will not take fire under 100 degrees will readily give off inflammable vapour at 80 degrees or 90 degrees, and hence always give rise to an explosive mixture of vapour and air in the reservoir of the lamp in which it is burnt. Until the letter of the Act is enforced, therefore, there will always be danger in burning paraffin oil in the lamps commonly used.

Fortunately the chances against the explosive mixture of vapour and air catching light in a paraffin lamp are very great. There is, however, one little hole in the upper part of every oil lamp, an aperture necessary to the steady burning of the lamp, and it is this which, doubtless, forms the touch-hole, by which fire has at times been conveyed from the flame of the lamp to the mixed vapour and air in the reservoir. But in paraffin lamps there is always a strong current of air passing over the external part of this orifice, in its passage upwards to support the combustion of the flame, and hence the successive portions of the inflammable mixture which escape through the aperture are at once so largely diluted with air as to be harmless. Should this current of air be arrested, as when a lamp is extinguished by placing a cap over the top of the glass chimney, or when the flame is put out by blowing down the chimney, or when the wick is being turned down and the chimney simultaneously removed by a cloth placed round the lower part of the chimney to protect the hands, or by other occasional circumstances, then the liability of the explosive mixture to ignition is greatly increased. Paraffin oil is an excellent and cheap illuminating agent, and if traders would only take a little more pains in refining it, so as to remove as much as possible of the unpleasant odour it possesses, and render it as safe as the old vegetable oils, which could be done with perfect ease, its present large sale would doubtless be immensely increased.

AN ATTEMPT TO APPROXIMATE THE DATE OF THE FLINT FLAKES OF DEVON AND CORNWALL.

By SPENCE BATE, F.R.S., &c.

THE large number of Flakes and broken fragments of Flints, found scattered over the surface of the country, has attracted considerable attention from archæologists.

In speaking of these flakes, care must be taken not to confuse them with those tools that are found in the Drifts of England and France, and which are the result of a more extensive manipulation than is evidenced in the manufacture of the flint flakes to which we allude in this paper.

These flakes are to be found on and near the surface of the superficial soil of the country. In the neighbourhood where flint is abundant their presence does not strike the observer so forcibly as in localities where, geologically, flint does not exist.

Throughout the counties of Devon and Cornwall flint flakes and chips are plentifully scattered. In some localities, such as in the neighbourhood of Barnstaple, and at the Lizard, they are abundant, whereas in other districts they are only to be met with as isolated specimens.

The character and appearance of these flaked specimens are various, some being well-formed arrow-heads, others representing the blocks from which the flakes have been struck, and others representing fragments of most irregular shapes. These last are more common in districts where the flint flakes are most abundant, but in those localities where the flints are scarce, the few specimens found generally represent well-formed flake implements; and these exist in a more or less perfect condition, according to the depth and nature of the soil in which they have been preserved. Those that are found on, or near the surface of the country are generally white, having the surface much oxidised, while those found more deeply in compact mould are fresh in colour, and but little changed in appearance from the freshly broken flint; and those specimens, obtained from peat, appear as fresh as if but fractured yesterday.

Some few years since Mr. Whitley reported that flaked flints

were to be found abundantly in the surface soil at Baggy Point, near Croyde, on the north of Devon, as well as along the coast.

The assertion by archæologists that these flint flakes are the result of human labour, either, as in the more perfectly adapted forms, of design, or as the waste material left in the effort to produce those forms, has given an interest and importance to them, as the only means left to us by which we may interpret the unwritten record of the early inhabitants of these islands. It is, therefore, with the hope of throwing some light on the subject, in its relation to the early history of the people, that the connection of these flint flakes with the geological conditions of the soil in which they are found, is here brought forward.

Near the small village of Croyde, at a place called Baggy Point, the flint flakes appear to be abundantly spread over the face of the hills and cultivated fields of the district.

Here, bordering on the sea shore, at the entrance to a little vale, through which a small stream of fresh water runs, these flints appear to have collected in considerable quantities.

The soil in which they are deposited is evidently the accumulation of the superficial soil of the hill, having been gradually brought into the valley, and possibly with it some few of the more superficially deposited flakes; but if so, they could not have been borne from afar, or they would exhibit signs of having been rolled or worn smooth by friction, of which there is not the slightest evidence.

Interspersed with these flints have been found other stones and evidences of the most primitive kind of human industry. These mostly exist in the form of smoothly-rounded pebble stones, evidently brought from the sea beach beneath, and which, from their pitted and polished condition, afford evidence of having been used as hammers and whetstones.

Two or three fragments of pottery have been found by Mr. Hall, and one by Mr. Whitley, that the latter believes to be the remains of the same utensil which Mr. Hall describes (*Intellectual Observer*, December, 1865, p. 355), as being "just sufficient to identify as having originally belonged to an urn, or some vessel of similar shape, which, when perfect, must have been $8\frac{1}{2}$ inches in diameter. One of the portions contains a small projection, evidently intended to serve as a handle. Bits of quartz have been worked up with the clay, so as to give it greater consistency. It is fashioned rudely by the hand, sun baked, and totally destitute of any attempt at ornamentation." The specimen procured by Mr. Whitley, and which now lies before me, according to my own judgment, has the appearance of being fire baked, and the presence of the bits of quartz seems to be accounted for only from the supposition of the manufacturers being too ignorant, or too indolent, to remove such great

sources of weakness to the vessel. Further evidence of fire is apparent in the presence of small fragments of charcoal, as also in that of numerous specimens of flint flakes, that have evidently been under the action of fire. A portion of a long bone, that is, by all anatomists who have seen it, believed to be human, being a portion of the tibia, assists, with the preceding recorded facts, severally to afford presumptive evidence that the spot on which they were found is in the neighbourhood where a colony of persons, the manufacturers of these implements, existed.

I have said that it is the site of the manufactory of these flakes, from the circumstance that with those that can be pronounced useful as knives, scrapers, awls, or arrow-heads, there are a large number of flakes and chipped flints that can only be the waste fragments struck off in the process of their manufacture, together with numerous fractured nodules of flint from which evidently smaller specimens have been broken, being the cores from which the knives and arrow-heads were made. These cores are tolerably abundant, according to my own observation, and, with that of Mr. Hall, as at 144 to 1,000 of the other flint specimens. The study of a great number of these cores shows that they invariably have a portion of one extremity first struck off, and at this flattened extremity the percussion is given that fractures off the several fragments, until a prominent angle is produced, which, upon being struck off, yields a flake that is broad at the base, and as the force of the blow dies out, the fracture thins out towards the opposite extremity into a sharp point, coinciding with the angle or corner of the core from which the flake is broken. Other shapes, such as scrapers and knives, are made, frequently the result of accident, but, no doubt, in practised hands, the effort of well-designed skill.

It is probably to many a matter of doubt how such arrow-heads could have been made with such rude implements, as the hammer stones that have been found with them must have been. Undoubtedly, to us, who require iron to be converted into steel before it is available for use in the construction of tools, it may be a source of wonder how these things were done; but a little experience will demonstrate that, while the fracture of a piece of flint into any given shape, with rounded stones and blunt hammers, is difficult, yet, with a tolerably sharp implement of fractured flint with a somewhat cutting edge, the thing is not only practicable, but easily fulfilled.

Mr. Whitley and Mr. Hall, who have recorded their opinions on the flint flakes of Baggy Point, state that "flint is not found naturally in that part of North Devon, as there is no chalk nearer than seventy miles, and greensand, with flint, occurs only in two fields at Orleigh Court, in the parish of Buckland

Brewer, distant from Baggy Point thirteen miles in a direct line, of which four are across Barnstaple Bay. Supposing, then, a manufactory of weapons existed at Baggy, it is evident that the raw material necessary for the formation of the tools must have been brought either by sea or land a considerable distance for that purpose."

Further on, I shall, I think, be able to show that the writers of this remark have overlooked, probably, the true source from which the natives obtained the raw material, and which is much closer at hand than these observers have believed. But, supposing that should not be the case, we have parallel instances in recent savage life. Mr. John Keast Lord, in his delightful book, *The Naturalist in British Columbia*, says, "I found, in rambling over the sandy plain near Fort Walla-Walla, numbers of flint implements, together with heaps of fragments. At some remote period of time, not easy to discover, the Indians evidently made their arrow-heads and other implements of flint at this place. The stone of which they were made could not have been obtained nearer than the Cascades" (a distance of 150 miles), "and must have been either traded from the Indians inhabiting that district, or brought from there themselves.

"I am," he continues, "disposed to think a regular flint trade was carried on by these inland tribes, at some remote period, with the tribes living on the seaboard and lower parts of Columbia. Not only were the flints traded, but dentalia (tooth shells), mother-of-pearl, and the barnacle parasite of the whale. I dug ornaments, made from the three marine productions from out a gravel bank, together with a skull, (which had not been altered by pressure during infancy,) in an Indian burial-ground, and a number of arrow-heads, fragments, and scrapers, made from flint or other hard material, which must have been brought a very long distance, as it has no representative in any rock found in the immediate neighbourhood."

We therefore can see no difficulty, in consequence of the distance of the raw material, for believing this to have been the focus of the manufacture of the large number of flakes that lie scattered within an area of at least twenty miles' diameter, since similar flints to those found at Baggy Point may be met with, in considerable numbers, on the adjoining hill, where the plough has never been, but where the soil has been washed by many storms from the surface of the rock. More sparsely they are to be found on the opposite hill, and along the coast to beyond Croyde Bay; also inland on the cultivated districts. And Mr. Whitley writes to me, to say that he has met with them at Bartridge, ten miles up the Taw valley. He says that, making a new road, nearly half a mile long, up the hill side, the flakes were found sparingly all the way; about 400 pieces of split flint

were found, 100 of which were typical flakes, some being as long as a finger."

The soil in the chief place of excavation, that is, in the Dell near Baggy Point, is about eight or ten feet above the natural slate rock of the country. The lower portion of the bed consists of yellowish clay, and the upper part of alluvial or surface soil brought down by atmospheric influences from the adjoining hill. A few inches above the clay a line of black mould existed, and it was in and above this line that all the flints and materials were found, that is within four feet of the surface, allowing six inches for soil that had been removed for farming purposes.

Along the coast from Baggy Point to Braunton Burrows a belt of sandy rock exists, soft in its structure towards the upper part, but hard as granite in the lower beds. This belt of sand has been pronounced to be a raised sea beach by Sir Roderick Murchisson and Professor Sedgwick, who, moreover, pronounced it to be one of the finest specimens of the kind. Over this, so-called, raised sea beach the surface soil has accumulated, and in this soil the flint flakes are found. Passing onward, we come to a tract of two or more miles of blowsand, which is separated from the sea by a broad and navigable river, the estuary of the Taw and the Torridge, from a low grassy place that stands at a level with high spring tides, and which is separated from the sea by a broad ridge of large pebbles, that rise to a height of about sixteen or twenty feet, and extend in length for about a mile and a half. Outside this pebble ridge, an extensive beach of fine sand covers the surface as far as low water mark at ordinary tides, beneath the sand, which at different places may be seen peeping through, is a bed of blue clay about six feet thick, beneath which is a layer of pebble boulders, similar in appearance to those which form the pebble ridge; and below these exist the angular fragments formed by the natural disintegration of the slate rock of the country.

In the bed of clay beneath the sand, the roots and trunks of trees testify to the former presence of vegetable growth, of which the kinds may be interpreted by the presence of acorns and nuts found in the clay; and the growth and luxuriance may be supposed from the quantity of the fruit, the size and remains both of the roots and the trunks, as well as from the circumstance that perforation in the nuts demonstrate that squirrels skipped among the branches of the trees that grew there. In this clay, in which roots, nuts, and acorns exist, flint flakes have been found in considerable numbers, one or two of which bear the impress of having been under the action of fire. Thus we see, in this place, that the flint flakes exist in connection with a submerged forest, whereas at Croyde and Baggy Point, at a distance of about four miles to the eastward, they have been found

in soil that overlies a deposit that has been, by our ablest geologists, pronounced to be a raised sea-beach.

The latest alteration of land upon this southern and western portion of the island, has been pronounced to be one of depression, and that the latest preceding that movement was one of upheaving. The former is shown in the numerous submerged forests around our western and southern coasts, and the latter is demonstrated in the remains of extensive sea-beaches that exist all round our shores.

It, therefore, would appear, that a careful study of the geological history of these formations, with which, in this locality, the flints are in connection, will assist materially towards our arrival at, at least, an approximation to the period at which the flints were deposited.

The first important study will be the careful analytical examination of the so-called raised sea-beach. This, as I have before said, exists between Baggy Point and Braunton Burrows, a distance of more than two miles, and rises from the present sea level to the height of about fifty feet. In some places, where the wash of the sea has been greatest, it is only to be met with in patches. This destruction has been carried to so great an extent near the spot where the flint flakes are most numerous, that a small high water island stands several yards off from the main land, the intervening ground having been washed away by the sea. Whereas, on the western side of Croyde Bay, it exists as a perpendicular wall stretching a mile along the coast. This so-called raised sea-beach consists of fine sand mixed with a few shells and pebbles towards the lower portion, the general aspect being a series of horizontal layers; while a closer inspection shows that these horizontal layers are built up by numerous thin strata exhibiting lines of false bedding in various directions. In the upper beds the stone is soft and friable, while in the lower it is hard and firmly cemented together, so that it is not easily broken by the geologist's hammer. In the upper layers the sand is generally free from extraneous objects, but towards the bottom a few shells and numerous pebbles of several kinds are found; the shells, as far as my own experience goes, consist invariably of single valves, of *mytilus edulis*, the common mussel, to which, upon the authority of Professor Sedgwick and Sir Roderick Murchisson, those of *cardium edule*, the common cockle, *patella vulgaris*, the common limpet, *solen*, or razor shell, and *donax truncatulus*, of which list only three, the cockle, razor shell, and donax, can live where sand exists, and these most probably, as previously observed, are represented only by the remains of dead valves.

The pebbles are found in the lower stratifications, the largest specimens being in the lowest, while a little higher, smaller spe-

cimens are found. These, as far as our observations support us, consist of rolled fragments of granite, quartz, trap, basalt, and unbroken nodules of flint; in fact, of materials very similar to those that exist near high water mark on the present beach, and which, probably, are obtained from the destruction of the so-called raised beach that overhangs them.

It was from the flints found on this beach, that were washed out of the ancient soft sandy rock, that I believe the old inhabitants at Baggy Point obtained the 'raw material' from which the flint flakes were fabricated, and which also probably accounts for the site of the chief place of manufacture being on the sea cliff.

In one place, resting on the present, and immediately supporting the ancient beach, is a large boulder-mass of granite, estimated to weigh about twelve tons. The upper portion, that is, all that can be seen, is smooth and rounded, in a manner that suggests the whole of it to be similarly water-worn; a circumstance that corroborates the opinion of Mr. Williams, in a paper published as a supplement to that of Professor Sedgwick and Sir Roderick Murchisson, in the *Transactions of the Geological Society* for 1839, that it has been borne from a great distance, probably by some iceberg, in the great glacial epoch. This granite boulder contains veins and crystals of red felspar, and is stated by Mr. Williams not to resemble the granite either of Dartmoor or Lundy Island, and that there is none like it nearer than Aberdeen. But this assertion must be received with caution, as I have recently been informed by Dr. Trefry, of Fowey, that every kind of granite is found in his quarries in Cornwall, and I have seen in his porphery hall at Place House, specimens very similar to that of the boulder in Barnstaple Bay. Therefore, it appears, that we need not go so far as Scotland to find the site from which this great stray rock may have been derived; but still we must acknowledge that it must have travelled from afar to have been worn so smooth, and that some enormous transporting power must have been required to bring this granite mass, even from the nearest granite district, to the place where it now rests.*

Not being a geologist, I cannot pronounce upon the period to which the boulder belonged, but of this there can be no doubt, that it was lodged in its present position before the deposit that is called a raised sea beach commenced; therefore, it is older than the sand bed that rests upon it. The elevation of the highest point of the raised beach is about forty feet; we must, therefore, suppose that the highest point of this beach must have been covered by water, at least at high tide, before the

* The presence of basalt found among the pebbles is suggestive of the North of Ireland.

elevation of the mass commenced. Forty or fifty feet being the greatest depth of the structure, it must necessarily follow, that the lowest portions of the stratified sand bed must have been from three to four fathoms below the level of the lowest tides. Now, if we examine the so-called raised beach, where it rests upon the slate rocks of the present beach, we shall find that specimens of the common acorn shell, the shore barnacle, *Balanus balanoides*, remain in abundance attached to the rocks, immediately covered by and embedded in the sandy deposit that is called the raised beach, the deposition of which probably killed them. Therefore, when the sand was first thrown on them, they must have been several fathoms under water. But we know that the species of *Balanus* that we find here cannot live in such deep water, that its normal habitat is a belt on our rocky shores, between half tide and high water; it is, therefore, evident, that the present beach must have been at or near its present level when these *Balani* were living; that is, that they were in the same position as they are now with respect to the level of the sea and land when the sand was first deposited on them; consequently, no evidence that any elevation of the coast line has taken place since the so-called raised beach was formed, has been proved.

To demonstrate what a thing is *not* may be comparatively easy compared to that of showing what it really *is*. In this instance, the evidence at our disposal may not be quite so conclusive in the latter as in the former point, but that which exists appears to be tolerably demonstrative.

The lowest stratifications alone contain pebbles, and these are all rolled and water-worn, and are such as may be frequently found belting a sandy shore at or above high water wash. Above these lines or pebbles the structure of the beds is that of fine comminuted sand, without admixture of foreign bodies. A stray valve of the mussel, and, according to Professor Sedgwick and Sir Roderick Murchisson, of the limpet and cockle, also may occasionally be met with; but these our experience has shown to have been deposited as dead valves, a fact that is demonstrated from the circumstances—first, that the mussel and limpet do not live in sandy shores; and secondly, that all the fragments of the bivalve shells have the concave surface of the shell turned downwards; as also all the specimens are those of one valve only.

The stratification of the beds themselves is such as corresponds with no sedentary deposit. False bedding is persistent in every part, and takes peculiar forms—sometimes those of semicircles and short oblique lines, often in opposite directions, in the same place, in close proximity, assimilating to lines of cleavage.

The upper portions of the beds are soft and friable, the lower is hard and petrous, occasioned, I believe, by the action of the sea water decomposing a portion of the calcareous material, and cementing the whole into a solid mass; and all the phenomena of the entire mass conduces to the conviction, that the so-called raised beach is, in reality, the undisturbed remnant of an extensive district of wind-borne sand, similar to that which now exists on Branton Burrows and in Croyde Bay, that formerly extended, most probably, to Baggy Point, reaching some way out towards the sea. Of this latter hypothesis we have evidence in the portions that remain hardened into stone, that still exist, capping the summits of the rocks on the beach to the extent of some two hundred yards seaward. Moreover, a study of the stratification of the hills of drifted sand, demonstrates a series of layers that assimilate to the various modes of stratification formed in the ancient bed, and which, I think, can be accounted for by no other means than the varying and ever-changing direction of the currents of the wind, that builds, destroys, and restores again, still ever adding to the heap. I would also draw attention to the circumstance that, in Croyde Bay, some of the lower layers of the present sand heaps are as hard as rock, and are probably, though part of the present sand beds, also co-existent, in point of age, with that which has been misinterpreted as an ancient sea beach."

The circumstance that all the flints that are found in the sand deposit are entire nodules, while those that are found in the soil that overlies it are fractured flints, demonstrates, I think, that the latter may have been produced from the former, and that the sand bed has been deposited since the existing beach has been at its present level; that the flints are more recent than the latest elevation of land upon the coast, that is, that the sand bed itself has been deposited since the date of the raised sea beaches around our coast; and that the flint flakes found in the surface soil were deposited after the deposition of the sand bed, a circumstance that must place a considerable period between the dates of the epoch of the raised sea beaches and that of the time when the flint flakes were deposited.

The next question that arises is, whether or not, since the flints have been found in the submerged forest at Northam Burrows, they may have been deposited prior to the latest depression of the land upon the coast. To determine this point, it will be necessary to analyse carefully the geological conditions of the deposits that exist in connection with the flint flakes there found.

The Northam Burrows form a large, grassy plain, that exists at the level of spring tide, high water. The Burrows are separated from the beach by an extensive pebble ridge, that affords

a strong barrier to the destructive force of the sea. The origin of this pebble ridge has not, by geologists, been determined; but I think the suggestion is most correct that supposes it to be the result of the wash of the sea removing the beds of clay that overlies a layer of pebbles. This pebble bed we have, by excavations made in several places through the clay, been able to trace within a short distance of the pebble ridge; and a recent boring, made for the purpose of obtaining water, has shown that, in diminished size, the pebbles exist as far up the sides of the shore as the stables of the Westward Ho! Hotel. I think, therefore, that there can be little doubt but that the terrible wash of the Atlantic thins off the clay, and so exposes the pebble bed below to the action of the sea, which, by degrees, carries pebble after pebble to add to the wall that protects the grassy Burrows from the destructive lash of the waves.

That the Great Pebble Ridge is moving inwards appears to be ascertained, but the rate of progress has not, I believe, been determined. But the gradual movement inwards of the Ridge, however fast or slow, exposes all the shore that is seaward of its protection to the destructive agency of the waves; it is to this, and not to any variation in level of the coast line, that, I believe, the submergence of the forest along the shore at Northam Burrows is due. The beach, to a very great extent, is covered by sand, which, to a large degree, protects the underlying clay from destruction; but that the sand is of comparatively recent deposition is demonstrated in the quantities of the shells of the *Pholas dactylis* that are found in the clay beneath, which must have lived, and burrowed their holes after the clay had been exposed to the action of the sea, and before the time that the sand was deposited on the beach; from the presence of which the beach is still free for a considerable distance above low water mark.

The fact, then, that the beach at the shore extremity is scarcely below the level of the Burrows, while the strata of which it is composed gradually thin out as it approximates towards the low water line demonstrates clearly, I think, that the submergence of the old forest bed is due to the removal of the superficial layer, and the encroachment of the sea, and not to the subsidence of the land with respect to the level of the sea.

Of course, these remarks refer only to the submerged forest at Northam. But there appears to me to be some reason for a reconsideration of the subject, whether a subsidence of land around our southern seaboard has taken place or not. The submerged forests on our coasts are numerous, and lands corresponding with these have existed within the period of history or tradition, and in some places, as in Torbay and Penzance, within the

memory of the present generation. These have disappeared, and the sea flows over them some fathoms deep, and yet we know of no alteration in the respective levels of land and water along the rocky portions of the coast, or other change by which we might recognise any subsidence of the land.

At the period of the general elevation that raised the ancient sea beaches to the height of thirty feet above the present sea level, the sea bottom around our coasts must have shallowed to the extent of four or five fathoms, an elevation that must have brought a large portion above the height of the highest tide. It is the old sea bottom, which, in favourable spots, became arboreal and fertile, that has continued to resist the destructive wash of the sea in the shelter of our creeks and bays until the period of man, that we see in the submerged forests around our coasts; and, therefore, as I before observed, if not in all places, certainly in Barnstaple Bay the encroachment of the sea is due to the destruction of the superficial soil of the district, and not to the subsidence of the land.

Assuming this to be true, of which I retain no doubt, it follows that the flints found in the clay must have been deposited since the latest downward movement, if any such has ever occurred upon our Devonshire and Cornish coasts, of which the submerged forests are supposed to afford evidence.

The next point of enquiry that suggests itself, is the relation that exists between the flint flakes found at Northam and at Croyde with those that lie scattered over the Western promontory. The places at which they have been found throughout Devon and Cornwall are sufficiently numerous to induce one to believe that they may be found to exist universally throughout the two counties. Around Barnstaple, in an area of twenty miles' diameter, they appear to be abundant. They have been found at Hartland Point; in some considerable numbers, on the moorland round Dismare pool; at the Stepper Point, near Padstow; in the Scilly Isles; in the neighbourhood of Penzance, Mr. Buller describes them as scattered over the surface, from St. Just to Tol-Pedn-Penwith; on Crusa Down, in the Lizard district; on the Plymouth Hoe, in the peat at Shaw Bridge, as well as at Princetown, where some beautifully worked specimens have been found with others, by the prisoners, on the surface of the gravelly soil, over which had accumulated about six feet of peat; at Cornwood, on the moorland; and on Windmill Hill, near Brixham. In all these localities they lie in the surface soil of the country; and, as far as there is evidence to show, must have belonged to the same common æra.

They have also been found in a basin on the top of the Maen rock in the parish of Constantine, near Falmouth. All these appear to me to differ from some that I obtained from an

ancient barrow near Trevoise Head, only in the circumstance that those found in the barrow are of less artistic forms than the others.

In order to approximate the relations that the flints of this barrow hold to those that have been found at Croyde, and elsewhere in the surface soil, it is desirable that we should give attention to the circumstances under which they were found, and the materials with which they were in connection.

In the barrow to which reference has been made at Trevoise, with the flints were found burnt human bones, enclosed within a coarse clay pot.

Within a few yards of this barrow there existed until very recently—some remains of which may still be found along the shore—an ancient shell bed, formed by the accumulation of the waste thrown away by the ancient people who resided there. In making an exploration of this Kitchen-middling, along with the shells of the mussel, limpet, and horse whelk, were found large quantities of the bones of the roebuck and sheep, stone hammers such as were found at Croyde, being rounded pebbles brought from the adjoining beach, together with specimens of pottery of different qualities, the coarsest of which cannot be distinguished from that found in the neighbouring barrow.

Now, if we turn our attention to the discovery at Croyde, we find that both Mr. Whitley and Mr. Hall obtained specimens of coarse pottery as well as beach stone hammers, both of which closely approximate in character and appearance to those that were found in the barrow and the kitchen middling, in Constantine Bay. In either case the pottery assimilates in appearance with that of the clay found in close proximity, and is of a quality that will bear comparison with the present bricks of the country.

I think that we are justified in arguing that a uniformity of material, when combined with a uniformity of design, and application of material, existing under similar geological conditions, is suggestive of an approximation in time. Thus the pottery found at Baggy Point assimilates nearly to that found both in the Kitchen-middling and the barrow at Trevoise, so also the character of the stone hammers from the Kitchen-middling resemble those found with the flints at Baggy Point; whereas the flint flakes found in the grave of the ancient chief are far less capable of adaptation as implements than the best formed of those that have been found at Croyde, Dosmare pool, the Lizard, and elsewhere, and thus I think that we are not stretching the probabilities beyond fair reasoning when we suggest that the flint flakes of Devon and Cornwall are of the same age as those found in barrows containing cremated human bones.

But it must strike the observer as peculiar, that the flint

flakes that some archæologists pronounce as being of the most primitive form of human implement, are found in such abundance in the subsoil of the western promontory, while the more perfect flint tools, such as have been found at St. Achieul, Abbeville, Hoxne, and in the drifts and caves of Europe; thus placing the more complex and perfected structure at a date, geologically speaking, far more early than the simple flake, a fact that is scarcely consistent with the latter being the earlier or more primitive form of the two.

In this point, it appears to me that those archæologists are at fault. My reason for so thinking is, that we find flakes, such as those found in Devon and Cornwall, still in present use by the native tribes of Western America; while I am not aware that the most degraded race is so far imperfect in skill, at present, as to use flint implements of the Abbeville type. The reason appears to me to be simply this, that the flint flakes represent parts only of more perfect tools, some being the heads of arrows, others being imbedded in wood so as to represent knives or crude saws, others being the armour of small javelins, and so on.

To suppose any of them as being arrow-heads is to assume that they were used in connection with a stringed bow,* an implement that evidently required a higher degree of thought to invent than either the hatchet or spear. Now, as arrows were in use, and retained as instruments of chase and war until a late period in this country, it must be tolerably certain that flint was retained, owing to the scarcity of metal, until long after the use of iron was known. In a Fougou, or subterranean artificial cave, recently explored by the Natural History Society of Penzance, in one of the galleries was found a flaked flint implement alongside of an iron spear-head (?) and some pottery.

Some observers have questioned the adaptation of these sharp flints as having been designed for the points of arrows, because they are the result of single blows in their separation from the core, and bear no evidence of having been afterwards touched to render them more perfect; while we find in some places flint

* Mr. J. K. Lord, in his *Naturalist in British Columbia*, says: "The Indian bow is a masterpiece of skilful manufacture; its elasticity does not in any way depend on the wood used in its construction, but on the elastic ligament procured from the fore leg of the elk; this is affixed to the wooden frame-work of the bow by a kind of glue made from the skin of the 'white' salmon, a glue when hardened, resisting the influence of wet to redissolve it. This elastic back to the wood acts as would an india-rubber band; the bow when bent takes an arrow about a yard in length, which it propels with a force equal, for a short range, to that of a rifle bullet. When an Indian shoots, five or six arrows are held in the left hand, and as the string, which is made of tendon, is hauled back, the right hand brings with it an arrow; this one is fired, another is seized, and as rapidly as one could reasonably count, the six arrows held in the left hand are discharged."—Vol. II. p. 252.

arrow-heads beautifully formed, with the barbs perfect, showing the manipulation of the manufacture. The ability displayed in the manipulation is evidence of skill in workmanship and of time required in the execution. But we are not to suppose that the highly wrought and skilfully laboured flint tool was one that was less prized than the expensively finished weapon of modern times, and therefore valued by the chief, the skilful warrior, or huntsman, as an ornament to his quiver or belt. An instance of this kind was told to me by Mr. Lord, the naturalist who accompanied the commissioners who defined the line of boundary between Canada and the United States, he found great difficulty in purchasing, from an Indian Chief, a flint dagger that he wore at his belt, and which had been retained as an heirloom through several generations, the value of which appeared to lie in its ornamental character.

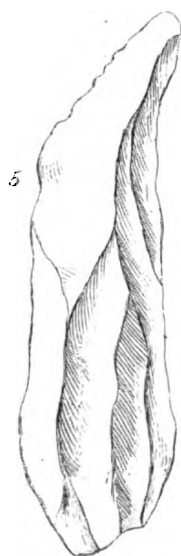
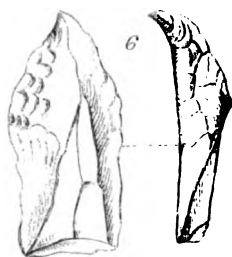
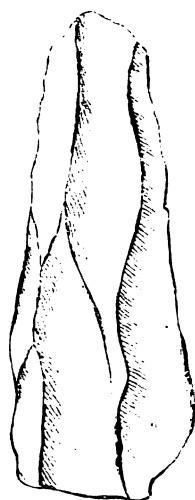
In time of war between rival tribes, or in the excitement of the chase, it is not to be supposed that the highly-wrought and valued weapon, such as shown in Figs. 1 and 2, would often be shot away in the dense forest, or over the marsh, or any place where the chance of recovery was less than certain. For ordinary purposes the easiest made would supply the greatest quantity in the shortest amount of time, and therefore be the most in demand and most extensively used.

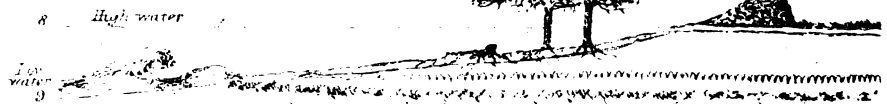
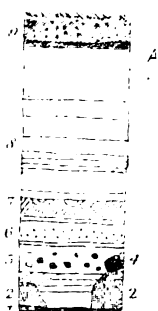
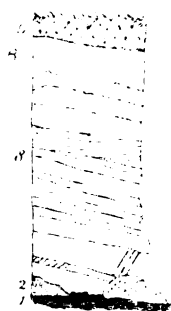
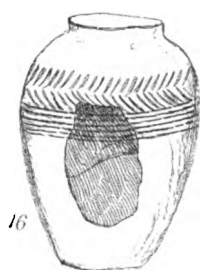
Thus we may assume that the majority of flake arrow-heads are chance productions, more or less so according to the practice and skill of the maker; and the warrior or huntsman selected from the chips those flakes that he found most readily adapted to his need, without reference to the original intention of the manufacturer. Just as Zipporah, Moses' wife, when in the Desert, in obedience to her husband made use of a sharp stone, because it was the best suitable for her purpose at the time.

Recently, while pursuing research in an ancient British burial-place, in which the Roman feature of civilisation has largely entered, we found in one grave a human skeleton, together with two vases, a bronze fibula, some rings,—that from their position appeared as if they had been worn on the toes,—parts of an arm-let, a specimen of black flint, a core, from which flakes had evidently been struck. Now, the presence of this core is witness, that, although bronze and iron were in use, flint was still valued after the Roman invasion.

It may be thought, that although flint is present in these graves, yet the character of the materials found with it, as well as the mode of interment, suggest a considerable separation in time from the flints found with the pottery in the north of Devon and Cornwall.

In comparing the pottery of these several places with one another, those that resembled each other most in character were





of necessity selected, but in the Kitchen-midding in Constantine Bay there were found specimens of pottery of various degrees of quality and workmanship, though neither assimilates perfectly with that found in the Romano-British grave-yard at Mount Batten. Yet they approximate so nearly that an archaeologist would not hesitate to pronounce them, historically speaking, of a uniform age, produced under different degrees of civilisation.

In his *Commentaries*, Cæsar tells us that the southern coasts of this island were inhabited by a different race from the inland parts; that central England was inhabited by those who called themselves natives of the country, dyed their bodies, and wore the skins of wild animals for clothes; on the sea coast, but not extending into Devon and Cornwall, by the Belgic Gauls, who were more highly civilised, used iron, and went to war in chariots, that came thither to plunder and invade the island. Here we have the element of discord, that must have kept the southern parts of England in continual ferment, which having quieted down, when their wars were ended the interlopers settled, and began to cultivate the land.

It is upon reasoning such as this that I contend there is no evidence to show, that the flint flakes which we find scattered over the surface of Devon and Cornwall may not have been co-eval with the history of the period that immediately preceded the introduction of Roman civilisation into this country.

DESCRIPTION OF PLATES.

PLATE IX.

- FIG. 1. Almond or leaf-shaped flint implement, carefully wrought on both sides.
 „ 2. Flint arrow head, carefully wrought on both sides.
 „ 3, 4, 5. Flaked flints. These, as well as the two preceding figures, of the actual size of the implements which were found under six feet of peat on Dartmoor.
 „ 6. Flint arrow head from a Cromlech on Cam-Brea, Cornwall.
 „ 7. Flaked flint from submerged forest at Northam Burrows, Devon.
 „ 8, 9, 10, 11. Flaked flints from Baggy Point, N. Devon.
 „ 12. Flaked flint wrought upon one side at the margins only.—Baggy Point.

PLATE X.

- „ 13, 14, 15. Flint cores from which flakes have been struck.
 „ 16, 17. Fragment of ancient pottery with and without ornamentation, from a Kitchen-midding in Constantine Bay, Cornwall.
 „ 18. Roebuck's horn, from the same place.

FIG. 19, 20. Ancient pottery from a British-Roman grave near Plymouth.

A, B. Diagram of an ancient bed of blown sand in Barnstaple Bay.

1. Present beach.
2. Rocks of do.
3. Granite boulder.
4. Balani on the rocks of the present beach.
5. Sand containing rolled pebbles and shells.
6. Do. do. do. of smaller size.
- 7 and 8. Layers of irregularly stratified sand.
9. Superficial soil.

C. Diagram of a submerged forest at Northam Burrows.

1. Surface soil.
2. Blue clay.
3. Rolled pebbles.
4. Slate rock.
5. Pebble ridge.
6. Trees of which only roots remain.
7. Sand.
8. High water line.
9. Low water line.

REVIEWS.

M. DU CHAILLU'S AFRICAN DISCOVERIES.*

A TRAVELLER who writes an account of his explorations, has two serious difficulties to contend against: if he narrates anything very extraordinary people are apt to be sceptical as to his love of truth, and if the incidents of his history approach the commonplace he is not unusually said to be dull. Unhappily for M. Du Chaillu, his work on "Equatorial Africa" met with a good deal of opposition from sceptical naturalists, but we think that in the volume he has now given us he has surmounted the obstacles we have referred to. He does not tell us "a more wonderful tale," nor is his narrative devoid of interest either to the geographer or the zoologist. The object, the author tells us, with which he set out upon the expedition, whose results he has now recorded, was to substantiate the statements which he made in his first work. He felt hurt by the "unfair and ungenerous criticisms" which were passed upon his first work, and he determined, by supplying himself with an extensive series of scientific apparatus, and returning to Africa, to put his assertions beyond all question. Such were the author's intentions on setting out a second time to explore that portion of Africa which lies immediately below the equator. M. Du Chaillu thought that, by ascertaining with astronomical exactitude the position of the several points visited by him in his travels, he should thus prevent any of those insinuations with which he was so abundantly assailed on his first appearance as an African explorer. This was why he took with him upon his last voyage a number of philosophical instruments, for estimating the height, temperature, longitude, &c., of each portion of the country which he visited. It is to be regretted, therefore, that his anticipations in regard to the employment of these implements of research were not fully carried out. In his first disembarkation his boat was upset, and those of his astronomical instruments which were not lost were rendered quite unfit for scientific use through the corrosive action of the salt water.

It is not our aim to follow M. Du Chaillu in his various wanderings from the moment he left the coast till he arrived in the land of the Ashangui. In the portion of his book especially devoted to the record of his progress from day to day among the natives, M. Du Chaillu does not provide a more interesting literary bill of fare than other writers on African travel. There are the same endless disputes with the natives, and the old trick of cultivating diplomatic relations with hoary chieftains, through the assistance of a

* "A Journey to Ashango Land, and further Penetration into Equatorial Africa." By Paul P. Du Chaillu. London: Murray. 1867.

quantity of beads or a bright cotton umbrella. In one page we are told of some prince with an unpronounceable name, and an equivocal code of morals, who kindly offers to place his "better" halves at the disposal of the accomplished white man. In another, we learn how some amorous princess, with more sentiment than propriety, protects the interests of the traveller. These incidents are varied by an occasional murder, and the changes are rung upon what African explorers term a "palaver." By the way, it would seem as if the aboriginal tendencies in this direction were contagious to Europeans, for we seldom find a work on Africa which does not extend over double the number of pages into which it might reasonably have been compressed. We do not, however, desire to call our author to account on this score; we would merely mention that the great bulk of his volume is occupied by the ordinary details of a traveller's diary, and is therefore of little importance to the scientific reader. It must, however, be admitted, to M. Du Chaillu's credit, that his book contains a good deal of matter highly interesting to the zoologist and the student of ethnology. We shall presently quote passages in proof of this, but in doing so we may mention that many of the facts recorded in his former work, and so strenuously denied by some of our leading naturalists, have been corroborated by the author's later inquiries. Concerning these we may especially refer to the controversies on the character and habits of the gorilla, and the *Potamogale velox*. These discussions may now be looked upon as closed, at least for the present. Most of M. Du Chaillu's assertions as to the habits, &c., of the gorilla, have been substantiated by his recent examination of these creatures in their wild condition, and the investigations of Professor Allman, of Edinburgh, show that in the affair of the *Potamogale* the author was correct and his critics did him an injustice.

There are three points in this volume to which our readers' attention should be directed. These are the history of the Obongos or negro dwarfs, the account of the African ant-hills, and the description of the skulls which the author brought home with him. It is to Professor Owen's pen that we owe the chapter on these latter, a fact which lends a scientific interest to the work such as might not otherwise attach to it. It seems to us that M. Du Chaillu might have done something more to investigate the tribe of Obongos than he seems to have attempted. The Obongos appear to be a most interesting, diminutive race, of an extremely degraded type, and it would have been of the highest importance to ethnology to have had a careful anatomical description of them. They are a tribe of dwarfs, dwelling in huts of the rudest description, and living upon the results of their hunting expeditions. They do not seem to be so small—if we may judge from the author's measurements—as M. Du Chaillu would have us believe. Indeed, so far as we can gather from the following description, they are a race closely allied to the Boschismen of more southern Africa:—

"The colour of these people was of a dirty yellow, much lighter than the Ashangos who surrounded them, and their eyes had an untameable wildness about them that struck me as being very remarkable. In their whole appearance, physique, and colour, they are totally unlike the Ashangos among whom they live. The Ashangos declare that the Obongos intermarry among themselves, sisters with brothers, doing this to keep the families together as much as possible. Their foreheads are exceedingly low and narrow, and

they have prominent cheek bones; but I did not notice any peculiarity in their hands or feet, or in the position of the toes, or in the relative length of their arms to the rest of their bodies; but their legs appeared to be rather short in proportion to their trunks; the palms of their hands seemed quite white. The hair of their heads grows in very short curly tufts. This is the more remarkable, as the Ashangos and neighbouring tribes have rather long bushy hair on their heads, which enables them to dress it in various ways. The young man examined had an unusual quantity of hair also on his legs and breast, growing in short curly tufts, similar to the hair of the head."

In his description of the white and other ants, the author displays that lack of minute observation which nothing but a long experience in the study of organisms can give. For example, it appears to us that some of the creatures which he puts along with the white ants (Neuropterous insects) are genuine Hymenoptera; and again, his descriptions, save in so far as they relate to the character of the habitation, and the larger external features of the insect, are useless as means of zoological diagnosis. Much excuse for this lies in the circumstance that the author's specimens were all lost in his retreat from Monoau Kombo, and therefore that he was obliged to describe from memory alone the objects he had seen. He describes five or six different kinds of ant, some of them being unquestionably Termites. His account of the *Mushroom-hived Termes* is interesting. Speaking of the habitation of this species he says:—

"These singular hives, shaped like gigantic mushrooms, are scattered by tens of thousands over the prairie of Otando. The top is from twelve to eighteen inches in diameter, and the column about five inches; the total height is from ten to fifteen inches. They are not all uniformly built, but differ in the roundness or sharpness of their summits. The hive is not so firmly planted in the ground but that it may be knocked down by a well-planted kick. When felled, the base of the pillar is found to have rested on the ground, leaving a circular hollow, in the middle of which is a ball of earth full of cells, which enters the centre of the base of the pillar, and the cells are eagerly defended by a multitude of the soldier class of the ants, which I took to be males, all striving to bite the intruder with their pincer-like jaws. On breaking open the ball—which, when handled, divided itself into three parts—I always found it full of young white ants, in different stages of growth, and also of eggs."

M. Du Chaillu's further description of his observations of this ant colony will prove most attractive reading to lovers of natural history, but the details are too extensive for introduction into these pages. Professor Owen's portion of the present work has some importance, although it establishes no law which has not already been deduced. He describes, in pure but not simple anatomical fashion, three skulls, one being that of a native of Fernand Vaz, and the two others being those of people of the Fan tribe, that strange group of cannibal Africans, of which M. Du Chaillu has more than once given an account. There is one statement of Professor Owen's which is of considerable interest: it relates to the dolicho-cephalic* character of these skulls. Speaking of this term as applied to the skulls brought over by the author, he says that it does not imply a "greater length of cranium than in Indian and European skulls, which would be called brachy-cephalic,† but merely a

* Long-headed.

† Broad-headed.

want of filling out of the brain-case, by lateral or vertical expansion." Here we may remark that the Professor takes the opportunity of saying a word in favour of his view that the brain of man is *absolutely* different from that of the ape, for in concluding the chapter he writes:—

"In all the negro-skulls in the present collection, as in those of Boschismen, Mincopies, Australians, and every other variety that has come under my observation, the essential characters of the archencephalous sub-class, and of its sole genus and species, are as definitely marked as in the skulls of the highest white races."

Altogether we may say of M. Du Chaillu's work, that it is interesting as a book of travels, and is instructive in relation to those departments of science to which the author has given his attention. If we were to be very critical, we should say that in many instances the style was rough and jerky. But on the whole the author's English is readable, and his book is good. M. Du Chaillu is not an Englishman, and cannot therefore be expected to distinguish himself in what so many English travellers fail—clear English composition.

POPULAR BOTANY.*

A WONDERFUL man, indeed, M. Figuiet appears to be. There is no subject which he is not ready to write upon, and we must confess that his compilations have a certain merit to recommend them. He is in the department of scientific book-manufacturers, what M. Dumas is in light literature. He wields a pen which, in the language of the "liners," is eminently "prolific." Not a year passes by without the appearance of some three or four large treatises bearing the stamp of M. Figuiet's factory. His great book on Insects has not yet been translated, but doubtless we shall soon have an English edition of it. Meanwhile, we have his "Vegetable World" reproduced in our "mother tongue," and it behoves us to say a few words about it.

There is hardly any branch of science which is undergoing so little radical change as botany. That which we were taught ten years ago is that which students learn to-day. This is at least the case in regard to the purely scientific divisions of the subject. Of course each day brings forth its list of newly-discovered plants, and in this way not only adds to the enormous accumulation of specific and generic names, but affords the botanist new facts from which to discover the natural affinities and the geographical distribution of the vegetable species. But as regards the physiology† of the plant—the offices of the various tissues and organs which compose it—there is little to be added, even in the year 1867, to the grand generalizations put forward in Schleiden's "Treatise," ‡ published so many years ago. Indeed, we may

* "The Vegetable World: being a History of Plants, with their Botanical Descriptions and peculiar Properties." By Louis Figuiet. London: Chapman and Hall. 1867.

† Always excepting the beautiful researches of Mr. Darwin on the subject of fertilization.

‡ "Principles of Scientific Botany, or Botany as an Inductive Science."

safely affirm that none of the works which succeeded that of the Professor at Jena is in any respect to be compared with it. So likewise as to structure, if we except the more recent inquiries of Mr. Arthur Gris, M. Chatin, M. Bornet, and a few others, little has been added to the knowledge acquired ten years ago. It may be gathered, therefore, that the preparation of a general work on botany is attended with no very insurmountable difficulties. Hence, as might be expected, M. Figuier's present work is by no means as inaccurate as most popular books on scientific subjects.

M. Figuier has divided his task into four portions: The organography and physiology of plants; the classification of plants; the natural families of plants; and geographical distribution. The division is a good one, but is not novel. Under these four heads M. Figuier discusses the natural history of plants; and, by the aid of illustrations—of which it is faint praise to say that they are admirably conceived and executed—and in a terse clear style, he certainly does much towards the "popularization" of botany. We cannot say, however, that the four divisions are equal in point of treatment. Clearly, the first, which is devoted to the structure and physiology of plants, ranks first also in order of merit. The portion in which the classification of plants, and the arrangement into families is given stand next, and the chapter on distribution is judiciously placed last for more reasons than one. If we have any fault to find with the classification, it is that in some portions it is more detailed than is necessary. The arrangement of the natural families it is impossible to complain much of, for the writings of Lindley have not been spared in this part of the compilation. The geographical portion of the subject, however, we must and do protest against; it contains no reference to important inquiries which have thrown real light on the question of geographical distribution. Indeed its scientific qualities may be represented by the word *nihil*. There is a great deal said about "the rich and varied vegetation of Asia," and so forth; but, on the whole, this part of the book is a poor reproduction of the old "physical geography" of our schools—a *science* which contains not a single generalization, and is full of questionable facts. In describing the organs of plants, M. Figuier has fallen into very few mistakes, but he has been guilty of some omissions, which the botanical reader must instantly notice, but which are of little importance to the amateur. There is only one other matter concerning the author, to which we must call attention. That is his tendency to become hyper-popular in explaining certain phenomena. It is one thing to confess one's ignorance of the nature of some organic operations, and quite another to assign them to the limbo of a mysterious agency. We do not therefore justify M. Figuier's position in the following assertion:—

"We must, besides, in order to explain the great phenomenon of the life of plants, bring in a force very superior to all these physical actions. This is the action of vital force, which God only bestows, and of which He alone directs the results."

We are puzzled to know whether these sentences are more remarkable for irreverence or bad grammar, but we cannot assent to their science. M.

Translated by Dr. Lankester, F.R.S. A few copies of this work may still be had of Mr. Hardwicke.

Figuier should rather have said: "Beyond this point we are unable to explain the process of life in plants; we may hope that further research will remove a great deal of our present ignorance, but meantime we must wait?" Does M. Figuier mean that life is the only power wielded by the Creator? if not, then which does he especially instance, vital force as something which "God only bestows." Where do the other forces come from?

We have done with the author, and come now to the translator, who modestly announces himself as W. S. O. He has no doubt had a difficult task to perform, and one which none but a translator is able thoroughly to appreciate; he has had to preserve the author's style, while rendering his meaning clearly intelligible; and, in addition, he has had to convert the Gallic scientific technicalities into English ones—a process utterly impossible for one unfamiliar with the subject treated upon in the original. In all cases, therefore, the impartial critic must lean toward the translator, and our sympathies extend too in this direction. But, making all allowances, we cannot award very high praise to W. S. O. for his exertions. He has certainly given us a good translation of the work of a writer addicted to occasional indulgence in the "grandiloquent" and "ornate," but he has many errors to account for, and these we hope to see removed in that second edition which the book is certain to go through. We need only allude to a few passages in which we find the rules of composition strangely violated. They are not special samples, but are typical of a general carelessness of style which pervades the volume. Thus, "They bear the name of stomates from the Greek word *στόμα*, 'mouth.' A *stomates* of *Cycas* under the microscope is seen in fig. 126." "It must be added, however, that at the same time that leaves transpire they also *reciprocate* and absorb water by their own surface." "In every case hitherto mentioned the *number* of flowers of the same generation are indeterminate in each group." We would ask the translator also to revise his scientific terms, names of writers, &c.; many of them are incorrect, as in the following instances: Unger, Scaleform, Destrin, D. purpusia, tracheii. The objections that we have raised are not serious ones; and when we consider the comprehensiveness, beauty of illustration, typography, and general accuracy of M. Figuier's work, we are bound to say of it, that it is a book admirably adapted to the class for which it is intended.

ASTRONOMY.*

WE are sorry to be compelled to admit the truth of Mr. Chambers's assertion, that astronomy is not cultivated in this country either as a study or as a recreation to the extent that it is on the continent of Europe and in America. We are not, however, prepared quite to consent to his explanation of the reason. There is no doubt something in the fact that astronomy has not been correctly popularized as a study, but still this hardly explains the circumstance. It is true that till of late we have not had a treatise which might be placed in the hands of those ignorant of mathematics—at

* "Descriptive Astronomy," by George F. Chambers, F.R.A.S., of the Inner Temple, Barrister-at-Law. Oxford: at the Clarendon Press. 1867.

least, such a treatise as would encourage the study of astronomy. But books have been published, which, whatever their shortcomings, ought to have engendered a love for astronomical pursuits, and we trust that to some slight extent they have been successful in this respect. May not the reason, or one of the reasons, lie in the supposition that our climate, cloudy skies, foggy air, and a condition of things productive of discomfort to the English amateur, is unfavourable to astronomical pursuits? We merely ask the question in order that amateurs may be assured that they may engage to advantage in the study of the heavenly bodies even in this country. We feel positive that if it were generally known that even with a cheap telescope a patient observer may make most important discoveries, the field of workers would soon become enlarged. Now this effect we think is likely to be achieved by the splendid volume which has been issued by the Clarendon Press. Mr. Chambers is one whose previous labours in the departments of astronomy and meteorology highly qualify him for the task he has undertaken, and few we think will be disappointed with the work he has now given us. "Descriptive Astronomy" is a large book, extending over nearly 900 pages, and abounding in excellent, and some of them novel, illustrations. There is hardly any division of his subject which the author has omitted the discussion of—unless, indeed, that of solar-spectrum-analysis—and he gives as his reason for this omission that the time has not yet come for regarding this branch of physics as a section of astronomy. There is some truth in this, and a good deal of sound sense, for it shows that the author wishes his treatise to be regarded as solid and accurate rather than sensational and startling. We wish we had room for a full analysis of Mr. Chambers's book, of which we are able to give no more than the most outline notice. We therefore all the more strongly urge our readers to take it up and examine it for themselves. It deals with the subject in its entirety. Abstract considerations are as much as possible avoided, except where their introduction is absolutely necessary; but all phenomena are carefully described, and the most recent discoveries find a record in Mr. Chambers's pages. The advice to workers is eminently good, being simple and practical, and such as the "intending" astronomer requires. The history of the science and the mode of construction of the several apparatus are also given. Finally, there is a well-arranged series of astronomical tables. With one of Browning's cheap telescopes and a copy of Mr. Chambers's "Descriptive Astronomy," even the amateur may look forward to establishing his fame as a student of the heavens.

POPULAR SCIENCE, *par excellence*.

SIR JOHN HERSCHEL is said to be our best popular scientific writer, and certainly his volume of lectures bears high testimony to the accuracy of the general belief. The lectures, which he has here reprinted, are certainly the most interesting, instructive, and intelligible essays on scientific

* "Familiar Lectures on Scientific Subjects." By Sir John F. W. Herschel, Bart., K.H. London: Alexander Strahan. 1867.

questions which it has ever been our good fortune to read. There is a force of style in them which bears the reader on, *volens volens*, while the methods of illustration, the well-selected analogies, and the clear description, render subjects hitherto obscure and difficult, lucid and easily grasped. The lectures were originally delivered before various local philosophical societies, and published in some of our literary journals. Some would say, why reprint them? We do not. It seems to us that the publisher has shown a wise discrimination in selecting them for reissue. They are upon several attractive subjects, and some of them rise so far in value above the merely popular, that we should like to see them enlarged and published separately. We refer especially to the three lectures on light, which extend over 180 pages of the present volume, and form a masterpiece which is certainly unrivalled. The other topics which Sir John takes up are—volcanoes and earthquakes; the sun; comets; the weather and weather-prophets; celestial measurings and weighings; sensorial vision; the yard, the pendulum, and the metre atoms; the origin of force; the undulatory theory (this lecture ought to go with the three on light); and the estimation of skill in target-shooting. It is rare to find in combination so much literary skill, tutorial power, and scientific erudition as this volume presents. It is no flattery to say of it, that it may be read by the *savant* with pleasure, and by the amateur with profit.

ORGANIC CHEMISTRY.*

IN our notices of Parts I. and II. of this work, we were compelled to give the author unqualified praise for the manner in which he had prepared his new edition. In this instance, too, we must do as we then did, for in no respect has the author left anything undone to render the volume on organic chemistry worthy of his own high reputation, and valuable both to chemical students and to manufacturing chemists. As a most comprehensive exposition of the theories and phenomena of modern organic chemistry it stands unmatched, and as a work of reference, not only upon the organic chemistry of the laboratory, but upon the complex organic chemistry of the manufactory, we know of no work which can equal it. The gas manufacturer, the dyer, the petroleum distiller, the soap and candle maker, the baker, the distiller, the wine merchant, will all do well to purchase Dr. Miller's third volume; and the physiologist and educated agriculturist will find in it much to interest and instruct them. This was true of the older editions, but it is trebly true of this one, which contains reference to all the results of recent research. The most striking feature of the volume is the introduction of the new notation; this feature may prove a little objectionable to the older students, but its employment was inevitable. The new notation has established its claims to recognition; it is beginning to be universally employed

* "Elements of Chemistry, Theoretical and Practical." By William Allen Miller, M.D., LL.D., &c. Third Edition. Part III. Organic Chemistry. London: Longmans. 1867.

by modern chemists; it affords many advantages over the old system, and it is not difficult to master. The "old school" reader, too, will be a little confused at first to find that sulphate of soda is now *sodic sulphate*, and that the carbonic acid, so impressed on their minds (not physically), is now become transformed into *carbonic anhydride*; but he will soon get over these little difficulties, and then, with the help of Dr. Miller's excellent powers as a teacher, he will walk over the field of organic chemistry without much stumbling. This third volume is the best of the three, and the most useful and suggestive. The physician, the chemist, and the manufacturer will all find something in its pages touching upon their respective pursuits and inquiries.

THE WORLD BEFORE THE DELUGE.*

A NEW edition of this highly popular work has been issued. Need we say it is not less handsome than the first. When we look at its multitude of illustrations, its luxurious paper, and its good typography, we must give the publishers every credit for their labours. The next point to be considered is the matter of the book. In the last edition this was certainly out of keeping with a good deal that modern geology has taught us. It is satisfactory therefore to find an improvement in this edition, which we are told was revised by Mr. Bristow. Few abler geologists could have been selected for the work, and we only wish that full play had been given to him; but we fear that he has been sadly trammelled in the execution of his task of revision. This we conclude from the following passage in the preface:—

"Many points which are more or less inferential, and therefore matters of individual opinion, and especially those on which M. Figuier bases his speculations, Mr. Bristow has left in their original form, rather than make such modifications as would wholly change the character of the book."

What this statement means, and how far the abstract proposition it involves, can be justified, we leave the reader to judge for himself. For our own parts we can only say, that while in some ways the book has been improved (especially by means of the additions made to it) it has been on the whole very little altered. M. Figuier describes the leading facts and phenomena of geology very well, and the profuse illustrations remove any obstacles that might otherwise meet the general reader; but his speculations are, in our opinion, very often more visionary than well-founded, and we must entirely dissent from his mode of restoring pre-diluvial forms. The pictorial Bible is an admirable book, but we do not see that its noble teachings are more enhanced, or the facts of geology more elucidated, by abstracting its suggestive pictures of the Deluge and the Garden of Eden to illustrate a treatise on popular geology. The woodcuts intercalated with the text, are excellent of their kind, and are numerous and well-selected, but the "ideal representations" are the badly-executed extravagances of a too-imaginative genius.

* "The World before the Deluge." A new edition. By Louis Figuier. London: Chapman and Hall. 1867.

THE SCIENCE OF HEAT.*

THIS excellent little manual was, through some oversight, left unnoticed in our last Number. It is clear, well written, and up to the date of modern discovery, and is so arranged as to be easily mastered by the intelligent student. The book is divided into three portions: in the first are described the various effects produced upon bodies by heat; the second contains the laws which regulate the distribution of heat through space; and the third relates to the nature of heat, its sources and its connection with other properties of matter. Mr. Stewart is one of our highest authorities on the subject of heat, and this fact alone should insure the success of his manual; but the book carries with it intrinsic elements of success; for it contains exactly what the University-student wants, and it is so arranged that the reader is led to take an interest in the phenomena of heat before being introduced to the complex laws which govern them.

Chemical Philosophy according to Modern Theories, by Dr. Adolphus C. Wurtz, F.R.S., translated by W. Crookes, F.R.S. London: Dutton. 1867. We could not possibly review this work in our columns, for it is such an advanced dissertation upon the modern philosophy of chemistry, that, even if we had the space at our disposal, the treatment of the subject would be too technical for our pages. We remember with pleasure seeing the lectures of Dr. Wurtz published in the *Chemical News*, and we congratulate the able editor of that journal upon his selection of the lectures, and on the ability with which he conducted the translation. The book is small, but it contains an able *exposé* of the modern theories; and we confess, with its translator, that for breadth of view, lucidity of expression, orderly arrangement of facts, and shrewdness and fairness in reasoning, Dr. Wurtz's treatise appears to be singularly distinguished.

The Inductorium, or Induction Coil, &c., by Henry M. Noad, Ph.D., F.R.S. Second edition. London: Churchill. 1867. We direct notice to this, a second edition of Dr. Noad's instructive little work on the induction coil. Those who are anxious to get an insight without much trouble into the wonderful phenomena connected with the operation of the induction coil should purchase this book.

The Year-Book of Facts in Science and Art, by John Timbs, F.S.A. London: Lockwood. 1867. This little volume is a *resumé* of scientific progress during the past year. The difficulties of such a compilation render mistakes inevitable, but Mr. Timbs's summary is more accurate than its class generally is. The cuttings are principally from the *Illustrated London News* and *Mechanics' Magazine*.

The Twin Records of Creation, or Geology and Genesis, by Geo. W. Victor Le Vaux. London: Lockwood. 1867. Adopting the extremely novel

* "Elementary Treatise on Heat." By Balfour Stewart, LL.D. Oxford: at the Clarendon Press, 1866.

and anti-heretical maxim of "*Magna est veritas et prevalebit*," Mr. Le Vaux, whose name we do not remember to have heard before in connection with science, treats us to some of the late Hugh Miller's conclusions. He has hashed the joint prepared in so savoury a way by the Scotch geologist; but it has sadly lost flavour in recooking. Mr. Vaux has a very good object in view, and those who are anxious to see the records of nature and the Bible contrasted should read his book. He thinks he may be thought presumptuous in offering a volume to the public, but the following explanation will doubtless be received as satisfactory: "From my childhood I have had a particular taste—indeed, I might say a passion—for the study of nature, and of geology in particular. The rugged mountain and lonely glen, the wild cascade and forest glade, have always had peculiar attractions for me." The book was originally addressed to some private friends, and as occasionally does occur in such instances, its merit was appreciated and the author felt constrained to publish it.

SCIENTIFIC SUMMARY.

ASTRONOMY.

THE *Deduction of the Mean Figure of the Earth* from comparison of the Anglo-Gallic, Russian, and Indian Arcs, is the subject of a communication transmitted to the *Philosophical Magazine* for February, by Archdeacon Pratt. The paper is one of the highest importance; but as the details are of too mathematical a nature for these pages, we merely call attention to the fact of the publication of the essay. Those especially interested can peruse the original memoir themselves.

The Solar Spectrum.—M. Angström in a memoir recently published, calls attention to two important results arrived at from his researches. The first is the certain presence of manganese in the sun, he having observed the coincidence of at least thirty lines. The other is the discovery of a new hydrogen line. The spectrum of hydrogen, presents, as is well known, three lines—two of which coincide with C and F, and a third with a line near G. The fourth line which M. Angström has observed is near the middle of the interval between G and H; it coincides with a very intense solar line, which he has called *h*. With Geissler's tube this line is very distinctly seen, although it is very much less feeble than the three others. This result is the more satisfactory, as the line *h* was the only one among those of a certain intensity, whose origin still appeared mysterious. The explanation of it which M. Angström has found in the spectrum of hydrogen, acquires an additional interest from the fact that the line *h* occurs several times in the stellar spectra, drawn by Mr. Huggins.

The cause of the Heat of the Sun and Heavenly Bodies.—On March 4, M. Patau called the attention of the French Academy to his memoir on the above subject. The memoir, however, has not yet been laid before the members.

The Solar Spots.—Herr Kirchhoff has published a reply to M. Faye, relative to the course of the solar spots. He says, whatever be the constitution of the sun, the spots can only be explained by a local diminution of temperature approaching or exceeding incandescence. "My hypothesis supposes the cause of this diminution to lie in the radiation of clouds, toward planetary space, of clouds produced by the condensation and isolation of the photosphere." Herr Kirchhoff admits that possibly other explanations of the cooling process, may better meet all the facts of the case, but he considers that the adoption of any of them which rejects the consideration of a diminution of temperature would be equivalent to asserting the natural laws are quite different on the sun to what they are on the surface of the earth.—*Comptes Rendus*, March 4.

Disappearance of a Lunar Crater.—Padre Secchi, writing from Rome, on February 14, states, in relation to the reports that the Crater *Linné* has disappeared, that he has recently had an opportunity of investigating this point. He says: On the evening of the 10th (February), between 8 and 10 o'clock, the Crater became lighted up, and one could see near the limiting circle a small point, and around it a very flat irregularly circular crown. The absence of proper illumination and the proximity of the moon to the horizon, prevented further observation. On the 11th, in the evening, *Linné* was already pretty well illuminated; and at 7 o'clock, one could see distinctly a very small crater, surrounded by a brilliant white crown, which shone brightly on the deep shade of the *Mare serenitatis*. The size of the orifice of the crater was about $\frac{1}{3}$ of a second or more; and the crown was a little larger than *Sulpicius Gallus*. Signor Secchi dwells upon this comparison, because he says it shows us M.M. Moedler and Beer, whose map he employs, should never have figured a crater so large and well-defined as they assign to *Linné*, for a white spot such as that which exists at present; in fact *Sulpicius Gallus* is actually much larger than the little crater which forms the centre of the spot.

The Meteoric Shower of November in Mexico.—M. A. Poëy writes to M. Elie de Beaumont concerning his observations in Mexico. He states that there was really no shower perceptible from his observatory. The following are the results of the inquiries made at the Observatory of Santa-Clara, by the French Scientific Commission under M. Poëy:—

Night of November 13 and 14.

Northern Hemisphere.		Southern Hemisphere.		Total.
From 12 P.M. to 1 A.M.	7 meteors.	12 P.M. to 1 A.M.	11 meteors	18
„ 1 A.M. to 2 A.M.	16 „	1 A.M. to 2 A.M.	12 „	28
Total	23	Total	23	46

Night of November 14 and 15.

Northern Hemisphere.		Southern Hemisphere.		Total.
From 1 A.M. to 2 A.M.	13 meteors.	1 A.M. to 2 A.M.	17 meteors	30
„ 2 A.M. to 3 A.M.	16 „	2 A.M. to 3 A.M.	10 meteors	26
Total	29	Total	27	56

It may be seen from the above figures: (1) That the number of meteors did not exceed the mean of ordinary nights; (2) That there were ten millions more seen on the night of the 14th and 15th, than on the preceding evenings; (3) That the maximum number was seen between one and two.

The probable Periodicity of the Comet observed at the Observatory of Marseilles on January 22.—This has received the consideration of M. Silloujelt. He has calculated—though with the assistance of very imperfect instruments—according to Cauchy's method, the elements of this comet. It results from his calculation—necessarily approximative—that the comet is periodic. He has obtained for its elements almost analogous numbers to those figured under the number 27 in Arago's Astronomy. This comet, therefore, would seem to be that which was discovered by Messier, in April 1771.

M. Faye's Theory of the Solar Spots.—The views of Herr Kirchhoff, given already, have been answered by M. Faye, who maintains that Herr Kirch-

hoff's explanation is in no way astronomical, and is unsupported by observation. In referring to his own theory of solar reflexion and parallax, he has confirmed the fact, which passed unnoticed up to the present time, that when, after the apparition of a beam or fillet of light thrown from one side to the other, a spot is divided into two parts, one of the halves, as if it had received an impulse in front, takes an abnormal motion of its own, while the other half continues alone its normal movement, with variations of velocity which only depend on the latitude.

The Laws of Isolation.—M. G. Lambert read a paper before the French Academy on January 28. The memoir referred especially to the temperature of the Arctic zones, and to the power exerted by the diurnal isolation of the sun, the principal cause of this temperature. The power of isolation in a certain place ought not to be confounded with the thermometric effect which is its consequence, but which depends upon a number of variable causes analysed by the author, and of which the technical details have been sent in an extended memoir upon isothermic lines, &c. Designating by L the heliocentric longitude of the sun, w = the obliquity of the ecliptic, w' = the angle formed by the axis of the earth with the circle of isolation, an angle which is equal to the declination, l = the latitude, we have the following equations to represent the graphic trace of the curve of isolation at each parallel and at each season:—

$$\begin{aligned}\sin w' &= \sin w \sin L \\ x &= L \cos (l - w') \\ y &= L \cos (l - w') \tan w' \sin (l - w')\end{aligned}$$

in which x represents the power of the diurnal isolation.

The French Academy's Prize for Astronomy has been awarded to Mr. MacLear, for the mensuration, at the Cape of Good Hope, of an arc of the meridian, and the publication of his great work, "Verification and Extension of La Caille's Arc of Meridian at the Cape of Good Hope," two vols., 4to. The celestial amplitude of the arc measured by Mr. MacLear differs only by a small fraction of a second from the amplitude found by La Caille, and this agreement contributes to maintain the reputation of the French astronomer.

The Cometary Theory of Shooting-stars—to whom does it belong?—The Abbé Moigno, who has broached this question, and who evidently feels strongly on the point, makes the following observations in our contemporary, the *Chemical News*, of March 15: "In a quite recent note inserted on March 3, in the International Bulletin of the Imperial Observatory, and on the 8th inst. in the Bulletin of the Scientific Association of France, M. Le Verrier resumes on the cometary theory of shooting stars, and persists in attributing the honour of it to himself, without condescending to mention the name of Schiaparelli, whose letters, however, have been published in a journal of great authority, the Meteorological Bulletin of the College of Rome, issued under the superintendence of the Rev. P. Secchi, and were translated by the writer before M. Le Verrier had published a single word of his researches. We are really frightened by this system of organized cool-blooded appropriation, and more so by these lines, the effect of which has been even more coolly calculated: Sir John Herschel, who, along with his son, Alexander Herschel, has paid great attention to shooting-stars, gives his complete assent to

the theory of the swarms of November. Poor M. Schiaparelli! Happily the *Astronomische Nachrichten* have collected the necessary papers, and he will soon be in a position of having his revenge."

The Difference of Longitude between Newfoundland and Valencia has recently been ascertained by means of the Atlantic Telegraph. It has been effected by Mr. Gould, who was sent to estimate it by the Coast Survey of the United States. A preliminary calculation gave longitude of Heart's Content, Newfoundland, in respect to Valencia, 2h. 51m. 56.5s. Time occupied by the electricity to pass through the cable, 0.32s.

BOTANY.

Distinction of Species among the Algae.—In the last number of the *Microscopical Journal* there is an able paper upon this subject by Dr. Braxton Hicks. He continues the controversy with Mr. Archer of the Dublin Natural History Society. Mr. Archer believes very firmly, that certain forms, which he and other botanists have described, are distinct species, fixed and immutable. Dr. Hicks doubts this. He contends that, in order to be convinced that some of the organisms described by naturalists are undoubted species, it would be necessary to have a knowledge of the whole development-history. This knowledge we do not possess, and since certain of the temporary conditions of some algæ resemble the forms called species there appears to be much force in Dr. Hicks's arguments. In his last paper, Mr. Archer advanced several arguments in support of his opinions, and among others he adduced the fact of conjugation as the most certain test of the fixity of species. He believes this phenomenon to be the analogue of pollen-impregnation, and therefore considers that it shows the maturity of the cells in which it occurs. But, in reply, Dr. Hicks asks, looking at the process itself, have we any direct evidence "that it is anything more than a direct fusion of the contents of two cells? Whilst admitting the value of the analogy, ought we to ascribe more value to the act than really appears? What, for instance, is it in *Spirogyra*? A process, of one cell joins with the process of another, and their contents thus being able to come into contact, fuse into one mass. Before the change began, it was impossible to perceive any difference between the two cells. Further than this, we often find in some species that, should no second filament be near enough, two adjoining cells of the same filament conjugate, by throwing out processes round the joint which divides them, and then their contents fuse." Dr. Hicks philosophically contends that, until we have proved that no true antheridia exist in *Spirogyra*, for example, we cannot look upon conjugation as anything more than a vegetative process, unconnected with the maturity of the cells in which it occurs.

The Frond-cells of Lemna and Wolffia.—Our readers will remember that we, some time since, recorded the discovery of a new British species of Duckweed, by Dr. Henry Trimen. This diagnosis was formed upon the external characters of the plant. But Professor Gulliver has shown that microscopic examination of *Lemna minor* and *Wolffia arrhiza* shows

decided differences of structure between the two. The former abounds in raphides, while in *Wolffia* there are none.

The Function of Barren Stamens.—Dr. Maxwell M. Masters, in a short paper recently published, gives a capital account of a plant now at Kew (in the palm-stove), and which he refers to *Dombeya angulata*. The most interesting part of the description, however, is that which relates to the barren stamens of this plant and their functions. Some light, he says, is thrown on the use of barren stamens by an examination of this plant. In the fully expanded flower the upper angle or point of each petal is about on a level with the stigma and the lip of the barren stamen, the outer flat surface of which latter, as well as the adjacent portion of the petal, are often dusted over with pollen, the two stamens, nevertheless, being a considerable distance beneath these organs. In less fully developed flowers, the barren stamens may be seen curving downwards and outwards, so as to come in contact with the shorter fertile stamens, whose anthers open outwardly, and thus allow their contents to adhere to the barren stamens. These latter, provided with their freight of pollen, uncoil themselves, assume more or less of an erect position, and thus bring their points on a level with the stigma, whose curling lobes twist round them and receive the pollen from them. "The use, then, of the long staminodes seems to be to convey pollen from the short fertile stamens to the stigma, which, but for their intervention, could not be influenced by it." Vide *The Journal of Botany*, March.

Is Calluna Atlantica a New Species?—This question is answered in the negative by Professor Asa Gray. In a recent communication, he says that an examination of specimens from Cape Breton, Nova Scotia, and New England, does not reveal the naked pedicels, broader sepals, and "tip of flowering branches, not continued into a leafy shoot while the flower lasts." These, it will be remembered, were the features on which the foundation of the new species was based. Vide *Silliman's American Journal*, January.

Vitality of the Seeds of Medicago Americana.—Some experiments, proving the wonderful vitality of the seeds of this plant, were lately made by M. Pouchet, the great advocate of the theory of spontaneous generation. Some of these seeds, which had been submitted to uninterrupted boiling for four hours, successfully withstood the high temperature, the outer integument resisting the water, so that, when the seeds were subsequently sown, the young plants came up in from ten to twenty days.

A Large Collection of Fossil Plants, prepared by the late Mr. Nicol, is said, by the *Journal of Botany*, to have been purchased by the Trustees of the British Museum. The collection is a most valuable one, and has certainly fallen into the best hands for the interests of science.

Fossil Botany.—Mr. Carruthers, of the British Museum, has published, in the *Geological Magazine and Journal of Botany* some extremely valuable papers on the Gymnospermous fruits of the Secondary Rocks of Britain. These papers are interesting not only for the full and clear descriptions they contain, but because they show how much may be learned of the structure and affinities of extinct plants, by the microscopic examination of sections of fossils. It is very remarkable, that the conclusions arrived at by Mr. Carruthers bear out, in some measure, those of Professor Unger. It seems that the fossil vegetation of the Secondary Period finds its nearest existing

kindred in the present flora of Australia. This fact is all the more remarkable, because it happens also that the fauna of the Secondary Period has its nearest allies in the existing fauna of Australia.

The Professorship of Botany in Trinity College, Dublin.—The chair vacant by the death of Dr. W. H. Harvey, our late greatest algologist, has been given to Dr. Alexander Dickson, of Edinburgh. Those of our readers who have noticed our references from time to time to Dr. Dickson's various memoirs will agree with us in thinking that the selection made in this instance has been a judicious one.

The Process of Fertilization in Fungi.—On this difficult subject a very elaborate paper appears, from the pen of Herr H. Karsten, in the *Botanische Untersuchungen*. Herr Karsten's observations tend to prove that several groups of fungi, whose fruits have hitherto been considered distinct, are produced in a manner common to all. We cannot here enter on an analysis of Herr Karsten's essay, but it will interest fungologists who read it.

The Examination of Menispermaceous Seeds.—Mr. J. Miers, whose valuable Memoirs on the Menispermaceæ are being continued in the *Annals of Natural History*, gives the following as a practical mode of examining the seeds of this order:—After macerating and freeing the putamen from its pericarpial covering, introduce the point of the dissecting knife along the peripheral line of suture. It is then easily separated into two valves, leaving the kernel in an entire state. "We thus see the true form of the cell, its position with regard to the condyle, and the mode of attachment of the seed, the embryo and the albumen, if present, being thus obtained whole and uninjured."

Chemical Reagents in Botanical Diagnosis.—The Rev. W. A. Leighton, so well known for his numerous contributions to the Science of Lichen-Botany, has accidentally discovered that if hypochloride of lime be immediately applied to specimens of *Cladonia* already moistened with hydrate of potash, some very curious reactions are produced. For instance, if only a very slight and scarcely observable reaction be produced by the hydrate of potash, the immediate application of the hypochloride of lime will bring out a full coloured yellow reaction, which colour may either remain permanent or be eventually obliterated. Mr. Leighton lays great stress on these chemical facts, and he contends that they afford a means of diagnosis better than any hitherto employed. Indeed, he asserts that, had Sir W. Hooker, and other great authorities, resorted to the chemical method, they would have achieved a better system of classification than that which they based upon mere "external characters and aspects." Vide *Annals of Natural History*, February.

A *New Semper-vivum* from the *Salvage Islands* is fully described in Scientific Latin in the *Journal of Botany* for January.

The Leaves of the Dilleniaceæ.—In a memoir, laid before the French Academy on the 18th of February, M. Baillon describes very fully the anatomical features of this group of plants. The structure of the leaves appears to be peculiar. Generally, they are composed of a heteromorphous parenchyma. The cells beneath the upper epidermis are stick-like, and of tolerably equal size, but, as one descends through the substance of the leaf,

they become more irregular. The lower epidermis is formed of cells of a very irregular outline, and, in certain species, bears stomata of an elliptical form. Bundles of raphides are present in large numbers, and give the leaf a sort of rough or rugose character. They consist of concretions of silica, and are unaffected by any acid save hydrofluoric. They are well seen in the leaf of *Cuscuta Americana*, of which M. Baillon gives a minute account. Vide *Comptes Rendus*, February 18.

The Nature of Sap-currents.—Herr Reichert has published an essay on this subject, and he states his opinions in a series of conclusions. Of these latter, the first three relate to the constitution of the sap-fluid. Herr Reichert says, that in all cells containing fluids which rotate, two distinct portions are present within the cellulose wall, viz., the central cell-fluid which occupies the axis, and the mantle layer which exists between the central cell-fluid and the cellulose capsule. The cell-fluid is generally transparent (*Tradescantia Virginica* being an exception); its chemical constitution is not clearly understood, and it is the portion of the cell-contents which does not participate in the rotation. The mantle-layer consists of the gelatinous protoplasm, chlorophyll corpuscles, other smaller particles, the cell-nucleus, and certain microscopic crystals.

CHEMISTRY.

New Test for Cobalt in Solution.—Mr. William Skey, Analyst to the Geological Survey of New Zealand, has communicated to a late No. of the *Chemical News* a new test for the presence of cobalt in solution. If, he says, ammonia in excess be added to a solution of cobalt in tartaric acid, then an addition of ferricyanide of potassium produces a very dark-red coloration. So intense is the colour thus produced by the ferricyanide, that it will reveal the presence of cobalt in solution when all other tests fail, its delicacy being about four times greater than that of carbonate of ammonia. A solution of cobalt, prepared as indicated above, so as only to contain $\frac{1}{60000}$ part of cobalt, when placed in a $\frac{3}{4}$ -inch test-tube, is very distinctly coloured by the addition of a soluble ferricyanide, and even when diluted down so as to contain but one part of cobalt in 400,000 parts of the liquid, the coloration is still distinctly visible in a bulk of a few ounces.

Action of Bismuth on Phosphoric Acid.—In the *Zeitschrift für Chemie*, M. Brown states the effects of bismuth on phosphoric acid as very remarkable. When a fragment of bismuth is thrown into "glacial phosphoric acid infusion" the metal fuses to a bright globule, from which small flames are emitted. This phenomenon is sometimes so strong that particles of incandescent bismuth are thrown out of the vessel, forming a shower of sparks. There finally remains a spongy mass of bismuth, and a white powder, which is phosphate of bismuth. The flames which appear arise evidently from the phosphide of bismuth which would be formed, and which decomposes by giving up its phosphorus, or by forming phosphuretted hydrogen in contact with the water of constitution of the phosphoric hydrate.—*Chemical News*.

Determination of Oxygen in Organic Analysis.—At the meeting of the Chemical Society of London, held on the 21st of February, Mr. E. T. Chapman read a paper, entitled "Limited Oxidation: Determination of the Oxygen Consumed," which contained a suggestion for a more facile method of estimating oxygen in organic analysis than that in general use. The details are much too technical for our pages, but we call attention to the paper, as perhaps interesting to those who are pursuing organic chemical investigations.

The Formula for Purpurine has at last been settled as $C_{10}H_8O_4$, thus putting an end to the controversy between M. Schützenbergen and M. Bolley. The latter now agrees to the formula above, but, in other details, there is still considerable difference between the views of these chemists.

New Petroleum Compound.—Chimogene is the name of a new substance procured by condensing the gases first coming over from petroleum. It has been produced by Prof. Van der Weyde, of Girard College, U. S. The new liquid boils at 40° , and produces intense cold by evaporation.

The Preparation of Tinctures.—On this important point some valuable observations have recently been made in the *Journal de Pharmacie*, by M. Filhol. It appears, from his inquiries, that many of the tinctures kept in our druggists shops and dispensed to patients must have very different qualities from those assigned to them in the treatises on *Materia Medica*. M. Filhol makes the following statements:—

"A tincture prepared from the leaves of a plant will be of a beautiful green colour, due to the presence of chlorophyll, and will, under the influence of hydrochloric acid, undergo transformations, which M. Frémy has described, and which I have studied myself. Now, these transformations do not take place in a tincture which has been prepared for several months, and the most essential characteristics of chlorophyll disappear. "The petals of the ranunculus, macerated in alcohol, give a golden-yellow tincture, which, on the addition of an equal volume of hydrochloric acid, turns green. After the liquid has been filtered, a yellow substance remains on the paper, and the filtered liquid is of a pure blue colour. Nothing of this kind takes place when the tincture has been kept some time. Then the liquid remains yellow in spite of the addition of hydrochloric acid. In this case the xanthine of the flowers has been altered, as well as the chlorophyll."

The Separation of Palladium and Copper.—A novel method for the separation of these metals has been discovered by Professor Wöhler, and has been described by him in the pages of the *Chemical News*:—The mixed liquids are dissolved in aqua regia, and the excess of nitric acid is driven off by heat. The liquid is then saturated with sulphurous acid gas, and a solution of sulphocyanide of potassium is added. This has no action upon the palladium, whilst it precipitates the copper in the form of a white subsulphocyanide, $Cu_2C_2NS_2$. This may easily be changed into Cu_2S or CuO , and the quantity of copper thereby ascertained.

Amount of Carbonic Acid in the Air.—Some interesting observations have been carried out by Mr. T. E. Thorpe, and have been described to the Chemical Society (January 17). His experiments were conducted on the method of Pettenkofer, an aqueous solution of baryta being used to absorb

the carbonic acid from a known volume of air, the excess of baryta being ascertained by the use of a standard solution of oxalic acid. Mr. Thorpe's first experiments were made in the Irish Sea, in August, 1865, on board the "Bahama Bank" light ship, which is situate seven miles from Douglas, Isle of Man, and consequently about equidistant from the shores of England, Scotland, and Ireland. The results and meteorological conditions are given in the form of a table, wherein it is seen that there is no perceptible variation in the amount of carbonic acid during the day and night, the hours of 4 A.M. and 4 P.M. having been selected for the observations, these times coinciding with the maximum and minimum temperatures. Similar experiments were made last year in many latitudes of the Atlantic Ocean during voyages to and from the Brazils. The results are nearly identical with the former, and the amount of carbonic acid is said to be 300 parts in 10,000 of air, as the general average of the whole series of seventy-seven observations.

A Test for Wood-fibre in Paper has been suggested by M. Behrend. The suspected paper is touched with strong nitric acid. The presence of wood is indicated by the paper being turned brown, especially on the application of heat. This test is said to be more certain than the sulphate of aniline one.

The Determination of the Nitrogen in Ammoniacal Salts.—Herr Knops' method, which is a modification of Herr Wöhler's, which consists in treating ammoniacal salts with bleaching powder, has been highly spoken of by M. Dietrich. According to an account in the *Philosophical Magazine* for February, the decomposing solution is prepared by precipitating good bleaching powder with carbonate of soda, and adding two to three grammes of bromine to a litre of the solution after it has been made strongly alkaline. Its strength is then estimated by a standard solution of arseniate of soda. Fifty cubic centim. of this solution had the power of liberating 200 milligrammes of nitrogen. For the determination, 50 cubic centim. were always taken, and substance always dissolved in 10 cubic centim. of water, or stirred up with it, in case it was insoluble. Making the usual correction for the volume used off, and allowing for the gas which remained in solution in the liquid, M. Dietrich obtained very accurate results with this process of Wöhler and Knops.

The Reducing Action of Zinc has been recently studied by Herr Stahl-schmidt, who has published a paper on the subject in *Poggendorff's Annalen*. In the presence of a soluble alkali, finely divided zinc reduces nitrates to nitrites in the most rapid manner. Hence, as has been suggested, zinc may be employed for the conversion of the former into the latter. Commercially, it may be obtained at a cheap rate. It is to be found in all zinc-works, and consists of—zinc, 39.99; lead, 2.47; cadmium, 4.09; oxide of zinc, 49.76; and carbonate of zinc, 3.29. Washing this crude powder in acids is all that is required to prepare it for the reduction of nitrates.

"*The Laboratory*," a new chemical and physical journal is, we believe, to make its appearance on the 5th of April. Its name affords a clue to the nature of the subjects on which it will treat. We trust the new venture may be a successful one, but we fear the commercial experience of those who have had to do with new technical and "class," scientific periodicals is

opposed to such experiments in publication. The new journal will, in form and size, resemble *Notes and Queries*, and rumour says it is likely to be ably conducted.

Action of Potassium on Hydrocarbons.—M. Berthelot continues his researches on this subject. At a late meeting of the Chemical Society of Paris he stated, that not only acetylin, but also cumol and naphthalin were attacked by potassium. The same effects were produced on anthracen, and most of the less hydrogenized hydrocarbons. Benzol and hydrocarbons rich in hydrogen are not easily attacked.

Thorina in Euxenite.—Professor Chydenius, of Helsingfors, in Finland, states that he has detected the presence of thorina in euxenite.

Chemical Analysis of Variegated Strata.—The relation between chemical composition and the variegated character of certain geological strata has been explored by Mr. George Mair, F.G.S. At a late meeting of the Geological Society Mr. Mair gave the results of some analyses of the light and dark parts of various slates, sandstones, &c., in which iron was sought, proving that the lighter blotches, spots, and stripes, contain a smaller proportion of the colouring oxide than the average mass—a proportion which implies an actual difference in the percentage of the metallic iron, and which could not be accounted for by any mere difference in the state of its combination. This shows, he says, an actual departure of a part of the colouring oxide out of the colourless patches, and a dispersive process which seems to be the very reverse of the segregation of nodules of carbonate of lime and carbonate of iron out of a clayey matrix. Among the forms of variegation referred to were: (1st) that resulting from the segregation of dark blotches out of a lighter matrix, the evenness of colour of which does not appear to have been materially affected by the withdrawal of a part of its colouring matter; (2nd) that resulting from the segregation of dark blotches out of a lighter ground, each of which is concentrically surrounded by a distinct and well-defined zone lighter than the general ground; (3rd) strata variegated with light blotches containing a smaller proportion of colouring matter than the general ground, but not arranged concentrically round a darker nucleus; (4th) the variegation of coloured strata with both light and dark blotches, containing respectively a smaller and larger proportion of the colouring oxide than the general ground, but which are not arranged, as in the second case, concentrically with each other.

Conversion of Carbonic Oxide into Formic Acid.—This metamorphosis, which is certainly one of the wonders of modern organic synthesis, has been achieved by M. Berthelot. Of the method pursued by M. Berthelot the following description was given by Dr. Grace Calvert, in one of his lectures before the Society of Arts:—"Oxide of carbon," said Dr. Calvert, "which is highly poisonous, is the gas chosen by M. Berthelot to produce formic acid. To arrive at this end, he pours, at the bottom of a large glass vessel, a strong solution of caustic lye of soda or potash, filling the vessel with oxide of carbon. After giving a rotatory motion to the glass vessel, the oxide of carbon is absorbed by the potash, and each two chemical proportions of oxide of carbon, in fixing one chemical proportion of water, are converted into formic acid, which unites with the potash to produce formiate of potash or soda."

Chemical Manures.—All who are familiar with scientific agriculture are

aware how dependent upon the chemist the husbandman is. It may, therefore, interest our readers to know the character of the mineral manures employed by our neighbours on the other side of the English Channel. The manure applied at the Emperor's model farm, near Vincennes, by M. Ville, is prepared as follows :—

Slaked lime	200 kilos.	cost	2 fr.
Phosphate of lime	400	„ „	80 „
Nitrate of soda	500	„ „	200 „
Potasse raffinée (carbonate of potash)	200	„ „	190 „
	1300 kilos.		472 fr.

The above is the quantity required per hectare. Vide *Chemical News*, February 8.

Labels for Reagent Bottles.—Now that the new notation and nomenclature are coming so much into general use, chemists can adopt no better method of familiarizing themselves and their pupils with the new system than by placing the new labels on their reagent bottles. In this way, their eyes being frequently turned on the bottles, they cannot fail to substitute the new formula and terms for the old ones. We are, therefore, glad to state that a very perfect set of new labels, well printed and gummed, has been issued by Messrs. Jackson & Townson, of Bishopsgate Street Within.

Separation of Strychnine from Morphine.—Bichromate of potash, when used as a test for strychnine, is ineffective if morphine be present. This is a matter of great importance, and which toxicologists should bear in mind. However, a remedy has been proposed by M. Rodgers, who states, in the *Journal de Chimie Médicale*, that the two bases may be separated by chloroform or by benzol, which dissolves the strychnine, but only partly dissolves the morphine.

New Filtering Apparatus.—The *Chemical News* states that an economic filter and percolator, of an ingenious and useful kind, has been devised by Mr. F. W. Hart. By a peculiar combination of syphon-tube and filtering medium, any test-liquid may be drawn from a bottle in a state of limpidity, and, if necessary, returned again turbid to the stock for refiltration. By slight modifications, the apparatus is used for filtering alcoholic ethereal or caustic alkaline solutions out of contact with the air, and it can be adapted to a water bath, so as to admit of the filtration of gelatinous liquids. The apparatus is specially contrived for use amongst photographers, but it is evident that there are many uses in chemical, pharmaceutical, and manufacturing laboratories to which this apparatus can be economically applied.

Glycerine in Crystals.—Mr. W. Crookes, F.R.S., has described the singular phenomenon of crystalline glycerine. The specimen in which the crystals were discovered had come by rail from Germany, and it is thought that the vibration of the railway journey and the extreme cold of the season conduced to the production of a solid state. Mr Crookes gives the following account of a portion of the solid crystalline mass :—“A large block of this solid glycerine, weighing several hundredweight, suspended in a somewhat warm room, took two or three days to liquefy, and a thermometer inserted

in the fusing mass indicated a constant temperature of 45° F. In small quantities the crystals rapidly fuse when the bottle containing them is placed in warm water. The original glycerine was pale brown; the crystals formed from it are nearly white, whilst the liquid which drains away from it is dark brown. In quantity, the solid glycerine looks very like a mass of sugar candy. The isolated crystals are sometimes as large as a small pea; they are brilliant, and highly refracting; when rubbed between the fingers they are very hard, and they grate between the teeth. Their form appears to be octahedral, but this is difficult to ascertain accurately, owing to the viscosity of the mother liquor which adheres to them." The specimen examined was first discovered by Dr. W. S. Squire, of the firm of Burgoyne, Burbidges, and Squire, of Coleman Street.

The Absorption of Hydrogen and Carbonic Acid by Melted Copper.—M. Caron has presented to the French Academy a memoir on this subject. The following is the account given of the mode of experimentation:—Copper of good quality, weighing about 200 grains, is melted in a vessel placed in a porcelain tube, and by degrees is passed over it a stream of hydrogen, the apparatus being so arranged that the copper could be seen during the whole operation. As soon as the metal fused it appeared to intumescence, and water was condensed on the cool part of the apparatus. When the oxide which the copper contains is completely reduced, the surface of the metal is as brilliant and mobile as that of mercury. On cooling, a little before solidification, the mirror-like surface becomes agitated and appears to boil up, the escaping gas projecting a multitude of fine drops of copper. The metal then swells, and the solidification terminates by a final incomplete eruption. The ingot of metal, after cooling, is found to be porous. Exactly the same phenomenon takes place when the hydrogen is replaced by carbonic oxide.

GEOLOGY AND PALÆONTOLOGY.

Colliery Explosions and the Barometer.—Mr. J. Rofe writes to the *Geological Magazine*, and shows that colliery proprietors have only to watch the barometer, and provide, in accordance with its indications, for the supply of air to the mines. Alluding to the well-known "Blowing well" of Preston, in Lancashire, he states that, some time since, in a well recently constructed by him as a cesspool to some chemical works, he observed the phenomena characterising the "Blowing well." When the atmospheric pressure diminished the air came from the well loaded, to a disagreeable extent, with the offensive vapour from the cesspool. On continuing his observations with a barometer, he found similar results. He concludes, from these facts, that a coal-mine must be regarded as a gigantic well, from which, when the atmospheric pressure diminishes, the air expands, and rushes out with great violence. This circumstance is not, of itself, dangerous; but if there be an excess of gas in the mine, and, at the same time, from accident or carelessness, a means of ignition, then, indeed, the consequences are very likely to be serious. Hence the barometer becomes the miner's safest guide.

Consolidated Blocks in the Drift of Suffolk.—At the meeting of the Geological Society, on January 23, Mr. George Maw recorded the occurrence of large isolated masses of consolidated sand and gravel in the drift intervening between the chalk and boulder clay of the high ground of Suffolk. Many of the masses are several tons in weight. Although they occur at a general level, they do not form a connected band, loose drift, out of which they were evidently composed, forming a horizontal combination of their strata. The drift is largely charged with chalk-detritus, which also occurs in the softer blocks. Some of the blocks are extremely hard and compact, and in these the sandy agglomeration seems to have given place to a crystalline structure; but the hardest of those found in situ were resolvable into sand by the action of hydrochloric acid, and appeared to be merely held together by a calcareous cement.

A Fossil Myriapod from the Scotch Coal-Measures.—Mr. Henry Woodward lately presented a paper to the Geological Society of Glasgow, describing a curious *chilognathous* myriapod, found by the late Mr. Thomas Brown in the upper coal-measures of Kilmaurs. The specimen described occurs in a nodule of iron stone coiled up somewhat in the form of the letter J, and measures about two inches. The body contains thirty segments, each of which bears a slightly raised papilla, indicating the position of the tracheal openings; while, to the sternum of each segment, a pair of slender feet appear to have been articulated. These feet are easily seen to be composed of a number of joints, as is the case with recent myriapoda. "No soft-bodied annelid would be preserved in this condition," the body-rings of worms which Mr. Woodward had examined, from Solenhofen, for example, being indicated rather by a stain upon the slab than by any relief evidence of their presence, as shown in the specimen described. Mr. Woodward concludes that this myriapod possessed a chitinous exoskeleton sufficiently firm and strong to leave the impression of its limbs and joints in the soft clay in which it was buried.

A new species of Plesiosaurus has been purchased by the British Museum. The specimen is from the Lower Lias, near Charmouth, and has been named, by Professor Owen, *Plesiosaurus laticeps*. It measures nearly 14 feet long, and, with the exception of the displacement of a few caudal vertebrae, the vertebral column is in a complete and natural state. It is mounted with the ventral surface toward the observer, and, with the exception of a portion of the paddles and part of the muzzle, the skeleton may be said to be complete.

Foliation of Metamorphic Rocks.—Mr. G. H. Kinahan has written a very interesting memoir on the above subject, the gneiss and schist of Yar Connaught having specially received his attention; and, from Mr. Kinahan's observations, it would appear that the foliation of these rocks seems generally to follow some variety of laminated and rarely the cleavage planes. Mr. Kinahan describes six varieties of foliation, one of which may follow the cleavage planes, while the five others follow the lamination; the parallel foliation being caused by parallel lamination; the oblique, by the oblique lamination; the spheroidal, by the spheroidal lamination; the crumpled, or wavy, by the crumpled lamination; and the curled, by the lamination that is round the nodules. An instructive case is cited of this structure in the

townland of Killaguile, where the foliation of the schist curls round nodules of gneiss, the latter being found to be obliquely foliated.

A new specimen of Telerpeton Elginense.—A new specimen of this interesting fossil reptile, which is the property of Mr. James Grant, of Lossiemouth, has been described by Professor Huxley. The casts described consisted of impressions of the bones of the skull, together with the lower jaw, the teeth, most of the vertebræ and ribs, the greater portions of the pelvic and scapular arches, and representatives of most of the bones of the fore and hind limbs. Professor Huxley concludes that the creature is a true reptile of the lizard group, and that it by no means belongs to the amphibia. The hind feet appear to be peculiarly anomalous, the fifth digit presenting only two phalanges—a structure which differs from that of all lizards, recent and fossil, which have been yet examined.

Fossil Man in the Rhine Valley.—In the Lehm of the Valley of the Rhine, near Colmar, there is a marly deposit composed of a mixture of clay, fine sand, and carbonate of lime. It forms part of the diluvial beds, and in it M. Faudel has found a number of human and other remains. These consisted of shells, bones of a huge stag, teeth of *Elephas primigenius*, and a human frontal and right parietal bone of a man of middle size. M. Faudel concludes that man was contemporaneous with the mammoth fossil stag and bison.

Varieties of Denudation.—In an able memoir which he has recently published, Mr. A. B. Wynne, after bringing forward an abundance of evidence to show that no one form of denudation can be supposed to have exclusively affected the outer form of the globe, draws the following conclusion:—That the similarity of the *general results*, notwithstanding differences in the causes from which they may have proceeded, and their close connection with geological structure, involves their origin in some obscurity, which may lead to error, if a prejudice exist in favour of either a marine or sub-aërial agency, and that while great changes are effected by the endless action of the sea, the equally continuous atmospheric agencies are sufficiently powerful to produce, in the lapse of time, results so enormous, that time also is required for their full appreciation.

Fossil Echinoderms from Sinai.—Dr. P. Martin Duncan, who has been examining the cretaceous rocks of Sinai, has written an interesting paper on the subject of his investigations. The existence of cretaceous rocks in the district of Sinai has been surmised for several years; but, owing to the scarcity of fossils, they have not been correlated with any of the Asiatic formations. An examination of the Echinodermata collected by the Rev. F. W. Holland from the limestones of Wady Mokatteb and Wady Badera has enabled Dr. Duncan to show their parallelism with the red limestones in South-eastern Arabia, the fossils from which he described in a former paper. All the species not determined are well-known forms, characteristic of the typical Upper Greensand of Europe; but those formerly described from Sinai by MM. Desor and D'Orbigny seem to be peculiar to that region. Dr. Duncan states that by adding the Echinodermata from Sinai to those from South-east Arabia, we obtain a fauna eminently characteristic of the Middle Cretaceous period; and, in conclusion, he drew attention to the interesting fact that the majority of the wide-wandering Echinoderms had a

tendency to vary from their types both in Europe and in Arabia, while the rest remained persistent in form.

The Glacial Period in America.—Mr. Thomas Belt has sent us a reprint of a memoir published in the *Transactions of the Nova Scotian Institute of Natural Sciences* [Vol. I. Part 4]. It is upon the above subject, and expresses the views of the author, who is evidently well acquainted with the glacial geology of North America. The following are the principal conclusions which Mr. Belt has drawn:—1. The arrangement of the heaps of granite in the flanks of hills, and the distribution in them of grain gold in Nova Scotia, are opposed to the theory of the submergence of the country, either during or since the Glacial period. 2. The submergence of part of eastern North America, during which the marine beds of the Champlain period were formed, was not participated in by the southern coast of Nova Scotia. 3. To explain the movement of land ice from the Arctic regions southwards, it is not necessary to suppose that the continent to the north must have been greatly elevated, nor do the facts connected with the distribution of the drift agree with such a supposition. 4. That there was some elevation of northern lands during the Glacial period is, however, probable:—*Firstly*, because all the oscillations of level of the lands in the Northern Hemisphere since the Glacial period, with which we are acquainted, have been greatest towards the pole; and *secondly*, because a rise of land sufficient to prevent the entrance of heated currents to the polar basin, would occasion a great accumulation of ice in the circumpolar regions, by the heat of the tropical and sub-tropical waters being spent in evaporation instead of, as at present, in melting the ice within the Arctic circle. 5. The drift-beds were formed during the retreat of the ice, and not during its greatest development. 6. Terraces and stratified beds in lateral valleys, were formed when these were filled with water, dammed back by the glaciers that still flowed down the main valleys.

The Glacial period, in its relation to the eccentricity of the earth's orbit, is the subject of a highly philosophical essay, which appeared in the *Philosophical Magazine* for February. The paper should be carefully studied by those of our readers who are interested in the point it deals with. The following paragraph will give an idea of the author's views. "When the excentricity reaches a high value and one of the solstice points is in *perihelion*, the difference between the temperatures of the two hemispheres must be very great. The hemisphere which has its winter in *aphelion*, and under a condition of glaciation, is much colder than the opposite hemisphere, which has its winter in *perihelion* and enjoying an equable climate; and the consequence is, the aerial currents from the pole to the equator must be much stronger on the colder hemisphere than on the warmer, because the difference between the temperature of the pole and the equator is greater on the former hemisphere than on the latter. When the northern hemisphere, for example, is under glaciation, the north-east trade-winds will be much stronger than the south-east. The *medial line* between the trades will consequently lie a considerable distance to the south of the equator. The effect of the northern trades blowing across the equator to a great distance will be to impel the warm water of the tropics over into the Southern Ocean. And this, to an enormous extent, will tend to exaggerate the difference between

the temperature of the two hemispheres." Mr. Croll gives a long series of tables showing the different values of the excentricities, at different epochs and from them calculates the dates of the Glacial periods.

Nests of altered rock in the grey Granites of the Southern Uplands.—The subject of the metamorphosis of rocks is now occupying geologists, and the memoir lately contributed to the *Geological Magazine* by Mr. James Geikie must therefore be of great interest to our readers. After dwelling at some length on the metamorphosis of aqueous rocks as shown in certain specimens which he examined, Mr. Geikie passed on to the above subject. These nests he says, must be familiar to all who have ever travelled over large granite districts. They consist of a fine-grained or semicrystalline dark baked-like rock, which is enclosed in a granitic basis. Frequently they are seen to show traces of lamination, but their most usual character is that of exceedingly fine-grained mica-schist whose dark or blackish hue is due to the large quantity of mica present. Most commonly, says Mr. Geikie, they are "of very irregular shapes, and are by no means confined to those portions of the rock that abut upon the outlying bedded or aqueous strata, but are scattered indiscriminately throughout the granite. The granite and the rock of a nest are firmly knit together, so that when a suitable edge has been obtained, a smart tap with the hammer will fetch away a good specimen to show the junction. This is commonly so marked that one may place a knife-edge upon it; but I have sometimes (though rarely) met with "nests" the fine-grained or compact rock of which seemed to pass by insensible gradations, both of colour and texture, into the outside granite. As far as my observation goes, the "nests" are, as a rule, harder, tougher, and less easily weathered than the granitic matrix, so that on exposed surfaces the "nests" usually stand out in relief. In some granites and granitoid rocks, however, the reverse is the case, the "nests" decomposing out and leaving behind them little pits and irregular hollows. When the granite and the contained nests are of the same or nearly similar hardness, it sometimes happens that decomposition has set in along the line that separates the one from the other, affecting both equally." Vide *Geological Magazine*, No. 30.

Origin of Petroleum.—Although nearly all geologists are agreed as to the organic origin of Petroleum, a great many are of opinion that the rock-oil is the result of a natural distillation of coal. Professor Hitchcock, however, no mean authority, comes to a different conclusion. Admitting, with all who have carefully studied the matter, that Petroleum is of organic origin, he says, that in his opinion it comes from plants, and that it is not, as some have suggested, a fish-oil or a substance altered to adipocere. It does not appear to be the result of a natural distillation of coal, since its chemical composition is different from the oil manufactured artificially from the cannels, containing neither nitro-benzole nor aniline. Moreover, petroleum occupied fissures in the Silurian and Devonian strata long before the trees of the Coal period were growing in their native forests. The nearly universal association of brine with petroleum, and the fact of the slight solubility of hydrocarbons in fresh, but insolubility in salt water, excite the inquiry whether the salt-water of primæval lagoons may not have prevented the escape of the vegetable gases beneath, and condensed them into liquids.

The Rev. W. S. Symonds and the Belgian Bone Caves.—We are sorry to be

obliged once more to call our readers' attention to an unpleasant subject. We allude to the controversy which took place some time since in the pages of the now defunct *Reader* relative to the paper on the Belgian bone caves, read before the Cotteswold club by Mr. Symonds and Sir W. V. Guise. Briefly, we may say, that Mr. Carter Blake accused Mr. Symonds of publishing intelligence which he had received in the course of conversation with M. Dupont and which the latter never intended to be made public. This was a very grave charge; and in commenting upon it in our October No. we called on Mr. Symonds for an explanation or contradiction of Mr. Blake's assertion. We were led to do this with more confidence from the circumstance that we observed no reply to Mr. Blake's letter in the *Reader*. Since then we received a communication on the subject from Mr. Symonds in which he produces the evidence of M. Dupont in justification of the course pursued in the publication of the paper on bone caves. Unfortunately this letter arrived too late for insertion in our January No. We have now therefore, even at the eleventh hour, to grant what is due in all fairness to Mr. Symonds—to completely exonerate him from the serious accusations expressed in Mr. C. Blake's letter. M. Dupont must know best whether he has been dealt with discourteously, and his letter therefore is the most satisfactory explanation of the matter. We cannot print this letter in full, but we give the following quotation from it as an illustration of what M. Dupont thinks of the affair:—

'Je ferai seulement remarquer que Messieurs Guise et Symonds m'ont prêtés des opinions que je n'ai pas, sur l'homme et les phénomènes quaternaires; mais je suis convaincu que ces inexactitudes dans leur compte-rendu ne doivent être attribuées qu'à une erreur involontaire résultant de l'emploi, dans la conversation que j'ai eue avec eux, de la langue française, qui naturellement ne leur est pas familière.'

This decided disavowal of the views held by Mr. Symonds and Sir W. Guise is an adequate refutation of Mr. Blake's statement.

Pre-historic Settlements.—In a series of *Essays* published late last year, Dr. Oscar Fraas of Stuttgart describes a number of pre-historic remains which he has discovered at the head of the brook Schussen, which runs into the Lake of Constance. In the course of excavating for a mill-pond several specimens were found. Among others some gigantic horns of the reindeer from four to five feet long; many of these were split to procure the marrow and some were converted into weapons, tools, &c., for agriculture, &c.

MECHANICAL SCIENCE.

Gas Engine.—A new form of engine worked by the explosion of coal gas has been recently introduced into this country by M. Hugon, who claims to be the original inventor of the Lenoir engine, which has been in use for several years. In this engine the complicated and delicate arrangements of electric batteries employed for the ignition of the gas in the Lenoir engine

are dispensed with. The ordinary slide valve is enlarged, and by an ingenious arrangement the ends of the valve, in its travel, project beyond the ends of the valve chest, so as to expose a gas jet, contained in a cavity of the valve. This jet is lighted at a fixed burner, and at the return of the valve ignites at the proper moment the mixed gases in the cylinder. M. Hugon introduces a jet of water into the cylinder at the instant of explosion which by its instantaneous evaporation diminishes the intensity of the temperature, keeps the cylinder cool, equalizes the pressure and assists in lubrication. He also provides separate pumps for maintaining the supply of the explosion compound and the gas for the exploding jets, at the requisite pressure.

Steam Rollers.—One of the great steam rollers recently introduced in Paris has exploded in the streets with fatal results.

Chilled Shot.—A controversy has arisen between Mr. Nasmyth the well-known inventor of the steam hammer, and Capt. Palliser as to the invention of chilled shot. Mr. Nasmyth, it appears, proposed cast-iron chilled shot, for penetrating armour, at the meeting of the British Association at Cambridge, in October 1862. Capt. Palliser, on the other hand, claims that the ogival-fronted form of his shot is an equally important part of the invention as the material of the shot. And he has certainly been the first to show how shot of sufficient hardness could be obtained, by the use of a particular quality of iron, and to demonstrate practically their effectiveness against iron armour. On the other hand, Mr. Whitworth, in a letter to the *Times*, whilst admitting the penetrative power of the ogival-fronted cast-iron shot when striking the target perpendicularly, still maintains that they are useless when striking obliquely, and that sound well-tempered steel shell with flat fronts are the only projectiles to be relied on under the varied conditions of naval warfare.

Mont Cenis Railway.—In a paper read before the Institute of Civil Engineers, Capt. H. W. Tyler has fully described the results of experiments with Mr. Fell's locomotive, which has been adopted for surmounting the steep gradients and sharp curves of the Mont Cenis route. On Mr. Fell's system an intermediate or centre rail is adopted, against which horizontal wheels worked by the engine are pressed by springs so as to yield any requisite amount of adhesion. The engine constructed for the Mont Cenis line is partly of steel; its weight fully loaded does not exceed 17 tons. There are two 15-inch cylinders working both the four coupled horizontal, and the four coupled bearing wheels. The pressure on the additional horizontal wheels can be varied by the engine driver at pleasure; during the experiments it amounted to from $2\frac{1}{2}$ to 3 tons on each wheel, or 10 tons altogether, but provision was made for increasing this pressure to 24 tons if necessary. During the official trials, with a load of 24 tons exclusive of the engine, on an average gradient of 1 in 13, with curves of 2 to 4 chains radius, the speed of 6.65 miles to 7.46 miles per hour was attained in ascending. With a load of 16 tons the speed was 10 miles.

Snow Ploughs.—In *Engineering* for March 1 are described and figured the snow ploughs which are employed by Mr. William Strandley, on the Highland Railway of Scotland, for clearing a way for the trains through the heavy snow drifts to which that line is peculiarly liable. The largest of

these consists of a massive timber framing, carrying a sort of gigantic cut-water and mould-board. Driven by five or six luggage engines, this plough will clear a way through drifts 10 or 11 feet deep at the rate of 25 miles per hour. For smaller drifts a medium sized plough is used attached to a pilot engine running in front of the trains, when occasion requires; and during the winter each engine is fitted with a still smaller plough, not rising above the buffer beam of the engine but capable of doing good service in drifts of 2 or 3 feet deep.

Safety Valves.—We need not fear that the sphere of mechanical research is exhausted, when so simple a matter as an ordinary safety valve still requires and rewards investigation. Mr. Thomas Baldwin has communicated to the Society of Engineers some very interesting experiments on the discharging power of safety valves, or the influence of the form of the valve on the lift of the valve for any given excess of pressure in the boiler over the weight with which the valve is loaded. The valve employed in the experiments was one inch in diameter, and was fixed in the manhole lid of an ordinary two-flued boiler. The following are some of the results.

Valve	Pressure in Boiler in lbs. per sq. in. in- cluding atmosphere		Weight on valve in lbs per sq. in. when the valve lifted the under men- tioned fractions of its diameter.				
			$\frac{1}{80}$	$\frac{4}{80}$	$\frac{8}{80}$	$\frac{12}{80}$	$\frac{16}{80}$
A . . .	65 . . .		58½	53½	52½	51½	
D . . .	65 . . .		53½	49½	48½	48	
L . . .	67 . . .		56½	52	49½	48½	47½
M . . .	67 . . .		45				

Valve A a disc valve, guided by outside pins; D, disc valve with inside wings; L, ordinary conical valve with 3 wings, and seat $\frac{1}{8}$ in. wide; M, disc valve $1\frac{1}{8}$ in. diam.

These experiments show that we cannot have the ordinary valve of sufficient area to allow the steam as rapid an exit as it ought to have unless the valves be very large. Mr. Baldwin proposes a spherical valve with a projecting seating, so arranged, that when the valve opens, the steam acts on a larger area of the valve than when shut. Such a valve $1\frac{5}{8}$ inch diameter he considers twenty times as effective as a disc valve five times its diameter.

Casting Steel under pressure.—Mr. Whitworth has invented a system of steel casting under enormous hydraulic pressure, with a view to produce a material of more uniform and ductile quality, and requiring less subsequent hammering or rolling. Steel shot of satisfactory quality have already been produced and the process is to be extended to the manufacture of ordnance.

Turret Ships.—A very important discussion has taken place at the Institute of Civil Engineers on the American Monitor system which has found a most able and competent advocate in Mr. John Bourne. There appears to be little doubt that additions to our Navy will be made, in which a modification of Capt. Coles's and Ericsson's plans will be adopted, and which will carry armour 15 or 16 ins. thick and 20-ton guns. In these the hull will follow the Monitor type, with its low deck almost level with the water, but the turrets will be carried up through a raised breastwork rising 7 to 10 feet above the deck.

METALLURGY, MINERALOGY, AND MINING.

Iron Direct from the Ore.—M. C. Duprey proposes to adopt a new method of manufacturing iron direct from the ore. He takes the ore—which has been freed as far as possible from earthy matter—and, having crushed it, he places it along with pulverised charcoal in thin sheet-iron canisters; the quantities employed being just sufficient when reduced to form a mass of iron of the usual weight of a puddle ball. An ordinary sand-bottom iron-heating furnace is brought up to a reducing heat, and with a thick clear fire the canisters are introduced. The furnace is carefully maintained at a reducing heat in the usual manner; in fact the process is continued much in the same manner as when sheet-iron is being annealed. Soon after introduction the canister is annealed and toughened, so as to assume a polished appearance. It should be the aim to keep the heat in this condition until the metal is thoroughly reduced: should it be increased the canisters may be prematurely destroyed. Deoxidation commences immediately on the introduction of the ore, as proved by the blazing of carbonic oxide from vents made for the purpose, and, by occasionally rolling, and at the proper time compressing the canister, the oxidation is caused to continue without intermission, until reduction is completed. The heat should then be raised to weld or paste together the particles of iron, and then canister and contents, being withdrawn, are welded, in any of the ways puddle ball is usually treated. The saving by this method is estimated at something like 30 per cent. on the present method.—Vide the *Artizan*, January.

What our Coal-measures yield.—At a late meeting of the Manchester Philosophical Society, Professor Page read a paper entitled “What we owe to our Coal-measures.” In the course of this he gave the returns of the yield of coal in the years 1857 and 1865 respectively, and as the contrast of the figures show the enormous increase in the quantity of coal removed from our mines, we give the statistics for the benefit of those of our readers interested in the subject:—

	1857. tons.	1865. tons.
Durham and Northumberland	15,876,525	25,032,694
Cumberland	942,048	1,431,637
Yorkshire	8,875,440	10,846,000
Derbyshire and Nottinghamshire	3,687,442	4,200,350
Warwickshire	398,000	859,000
Leicestershire	668,750	965,500
Staffordshire and Worcestershire	7,164,625	12,200,000
Lancashire	8,565,500	11,962,000
Cheshire	750,500	850,000
Shropshire	750,000	1,135,000
Gloucestershire, Somerset, and Devon- shire	1,225,000	1,875,000
North Wales	1,046,050	1,983,000
South Wales and Monmouth	7,132,304	12,036,587
Scotland	8,211,743	12,850,000
Ireland	120,630	123,500
	65,395,707	98,150,587

Ensuring the Purity of Silver.—It is no easy matter to make sure of the purity of silver. To those, therefore, who are working at this branch of metallurgy we commend the admirable memoir of M. Stas, in the *Annales de Chimie*, vol. lvi. p. 413. It has been translated into the *Chemical News* for February 22.

Composition of Boronatrocalcite.—This peculiar mineral has had its composition variously set down by different mineralogists. Lately, however, Mr. George Lunge has taken up this mineral for investigation. In a paper published in the *Chemical News* he goes fully into the history of the analyses given by his predecessors, and after explaining the method adopted in his own inquiries, he sets down the formula as follows:—



This is very nearly exact; there must, however, be a magnesium substituted for a very small quantity of calcium.

The Metal Manufacture of Prussia.—The forges and foundries in Prussia amounted in 1864 to 1,421. The total production amounted to 1,610,000 tons of common metals and 56,701 lbs. of silver, representing in money a sum of £5,846,187.

Telegraphic Communication in Mines.—At the Trafalgar Colliery, in the Forest of Dean, Mr. Brain has exerted himself to provide electric communication between the men descending the shaft and those in the engine-room, and above and below. The instrument is the same as one used on the Metropolitan Railway. It is fixed in the engine-room in front of the engineer. At the pit bottom the "hanger-on" is provided with a pair of electrical tappers, coloured respectively white and red. On touching the white tapper the bell in the engine-house is instantly struck, and the words "go on" show themselves on the dial plate attached. On touching the red the bell is struck as before, and the word "stop," in white letters on a red ground (as indicative of danger), is shown. By a repetition of the touch any number of knocks may be given. This also has been found to answer admirably. Electrical communication has also been laid in by Mr. Frost from Mr. Brain's office to different parts of the works, so that he can be instantaneously communicated with on any matter affecting the colliery. The instruments employed are the common needle, and with bells attached. —*Vide Mining Journal*, February 23.

Petroleum as Steam Fuel.—Mr. Richardson's experiments, conducted under the auspices of the Lords of the Admiralty, appear to have met with more success than some people anticipated. The trials were made with the petroleum boiler in Woolwich Dockyard. Mr. Richardson succeeded, during the latter period of the experiments, in evaporating 18.91 lbs. of water per pound of creosote during a trial of seven hours. The new fuel gave off at times a great deal of smoke, which caused a most offensive effluvia, the construction of the boiler being such as to impede a full gaseous blast, sufficient to destroy and consume the smoke as intended. Mr. Richardson has, it is understood, in consequence, applied to the Admiralty for a large common marine boiler, for the purpose of future trials. It was stated, as the opinion of the local naval engineers and other officers who were present, that with such fuel the gunboats in the tropical seas would

be rendered habitable and comfortable. The experiments were attended by a very large number of persons, representing the principal engineering and shipping firms, and also by many owners of steam yachts, who are desirous of using the new fuel instead of coal.—Vide the *Times*.

Oil-wells in Baden have been recently discovered, and are said to be as productive as the American springs. The oil is reported to be excellent. The locality of the wells is Wiesloch.

Gun-cotton as a Blasting Material.—We learn that experiments have recently been made in one of the Yorkshire coal-mines as to the value of this substance as a substitute for gunpowder. It appears from the trials already made, that, besides the superiority in power of gun-cotton over gunpowder, it possesses—what in a coal-mine is most important—the property of emitting no flame. Hence it can be used in cases in which the employment of gunpowder would be positively dangerous.

The Separation of Lead from Argentiferous Lead Ore.—The French correspondent of the *Chemical News*, who displays a wonderful faculty for collecting and popularising the most recent scientific news, states that M. Cordure has been more skilful than his predecessors, inasmuch as he has made use of the affinity which lead has for silver, in order to extract the former from the above-named ore. When the argentiferous lead is melted, a small quantity of zinc is added, and, after an energetic brushing, the mixture is allowed to repose. The alloy of zinc and silver, being lighter than lead, rises to the surface, and, as it is less fusible, it cools sooner. By watching the proper moment the silver can be skimmed off, united with zinc and a small quantity of lead. The zinc and the lead are separated by remelting the skimmed mass, and oxidising, by means of a current of hot air or superheated steam, and treating afterwards with hydrochloric acid; the residue is submitted to cupellation. Nothing hinders the chloride from being utilised in its actual state, or being transformed into carbonate of zinc.

Prevention of Accidents from Fire-damp.—The explosions which now so often occur in our mines are terribly destructive of life and property; but, strange to say, if they were much more frequent they would be less dangerous. If, in fact, the gases were caused to explode before they have collected in any large quantity, no serious damage would result. This is the principle of the remedy proposed to the French Academy by M. Somonet. He suggests the introduction into all the "drifts" of electrical conducting wires, so that the inflammable gases may be set on fire by interruption of the electric current before time has been given for them to collect to any dangerous extent.

New Reactions of the Oxide of Tungsten.—It has been pointed out by Mr. Skeay, of the New Zealand Geological Society, that there are other reactions of tungsten than those already indicated in books. If, for example, he says, tungstic acid is made red-hot, and then brought in contact with a cold surface, it becomes permanently black. This is due to the formation of an oxide. The hot acid dropped into kerosene oil gives rise to the same effect. The addition of acetic or tartaric acid prevents the blue precipitate of oxide (resulting from the deoxidising of the acid by zinc) from being thrown down and dissolves it, thus forming a characteristic blue solution.

Crucibles for Metallurgic Operations.—For inquiries in which a very high

temperature is employed lime crucibles are used, but there is much difficulty in preparing them, and when made they are often broken. One of the great difficulties in the way is that of obtaining blocks of lime of a sufficient size for scooping out a crucible, most large blocks being cracked. Clay crucibles lined with lime have been tried, but they too have failed, being often melted themselves. Under these circumstances the following method, suggested by Mr. D. Forbes, F.R.S., appears to be a good one. A clay crucible, of somewhat larger capacity than the desired lime one, is filled with common lamp-black, compressing the same by stamping it well down. The centre is then cut out with a knife until a mere shell or lining of lamp-black is left firmly adherent to the sides of the crucible, and about half an inch or less in thickness, according to the size of the crucible; this lining is now well rubbed down with a thick glass rod until its surface takes a fine glaze or polish, and the whole cavity is then filled up with finely-powdered caustic lime and pressed down as before, and a central cavity cut out as before, or the lime powder may be at once rammed down round a central core of the dimensions of the intended lime crucible. The lime lining is soft before it is placed in the furnace, but it soon agglutinates, and forms a compact crucible, which is prevented acting on the outer one by the intermediate stratum of lamp-black. This crucible will stand the heat of melted wrought iron or cobalt without fusing or cracking.—*Vide Chemical News*, January 4.

A Mineral of Yttria in the Alps.—In the *Annalen der Chemie* Herr Wartha describes, under the title of Wiserine, an Yttriferous mineral which has been found in the Haut-Valaise. It crystallises in square-based prisms similar to zircon. It was supposed to contain silica and titanitic acid, but M. Wartha has found this to be an error, and that, excepting a little iron, it contains only phosphoric acid and yttria. It is a phosphate of yttria, identical with the xenotime of Berzelius.

THE MEDICAL SCIENCES.

The Structure of Muscle.—In a late No. of Siebold and Kölliker's *Zeitschrift*, Professor Kölliker publishes a paper on the subject of the compartments seen in transverse sections of muscle. These were described some years since by Herr Cohnheim, whose views have now been corroborated by Herr Kölliker. In the present paper, the author concludes that the muscles are really composed of fasciculi, and that the material which binds the fibres together is different from that which unites what Mr. Bowman has styled the *sarcous elements*.

Distribution of the Rods and Cones in the Retina of Mammalia.—In the last No. of the *Microscopical Journal* there is a very able translation and condensation of Herr Schultze's recent memoir on the retina. Those who are interested in the comparative anatomy of the retina should read this paper attentively. It is full of interesting details, and, among other matters, it gives an account of the distribution of the rods and cones of the retina in

mammalia. From this we learn, that among the lower mammalia there is a remarkable diversity with respect to the distribution of the rods and cones. Whilst most of our larger domestic animals, especially the horse, ox, sheep, pig, and dog, present an arrangement of those elements resembling that which is seen in the human subject and in apes [except, of course, in the absence of the *macula lutea*], the cones, according to Herr Schultze's observations, are entirely wanting in bats, hedgehogs, mice, moles, and guinea-pigs. A sort of intermediate condition is met with in the cat, rabbit, and rat, in which animals are found either very slender true cones, as in the cat, or merely indications of them, as in the rabbit. But, in any case, the rods preponderate so much that the cones among them may readily be overlooked. In the rat, the rods are the longest and slenderest which Herr Schultze has yet found.

Structure of the Liver.—Dr. Lionel Beale's opinion as to the structure of the vertebrate liver has been recently substantiated by the researches of Herr Hering. This histologist states that the liver is constructed like the other secreting glands. It is of the tubular type, with canals, anastomosing in every direction, and having a tendency to form a series of networks. Like other secretions, the bile travels along glandular canals surrounded by glandular cells. It is easy (he says) to observe this arrangement in the livers of vertebrates. Five or more cells are disposed in simple layers around the circular and minute aperture of an hepatic utricle seen in transverse section. This arrangement loses itself insensibly in that variety of structure in which there are no utricles properly so called. Occasionally may be seen four, three, or even only two cells, uniting to form a biliary canal. The Russian anatomist denies the existence of hepatic trabeculae of biliferous capillaries, and believes that the biliary cells are persistent. He looks upon serpents' livers as the only organs for minute inquiries upon the subject.—*Vide Lancet Record of Science*, March 2.

Blood-poisoning after Surgical Operations.—The researches and experiments of M. Maisonneuve prove that nearly 95 per cent. of the sequelae of surgical operations result from the action of morbid products developed in the wound, and subsequently absorbed into the system. He puts forward his ideas in the following systematic fashion:—1. The blood and other animal fluids, when exposed freely to the air, or in contact with aqueous substances, soon lose their vitality. 2. Once dead, they are liable to putrefy under the influence of heat, moisture, and air. 3. The products of such putrefaction are highly poisonous. 4. It is the same with such secretions as the urine, bile, and intestinal juices. 5. In infiltrating the permeable tissues with which they are in contact, these poisoned liquids give rise to gangrene, erysipelas, &c. 6. These same liquids, either by themselves or mixed with the special products of inflammation they provoke, can, in entering the circulation, alter the blood and disturb important functions. 7. After their expulsion from the general blood-vessels, they may remain in the capillaries, the parenchymata, serous tissues, &c., and give rise to abscess, anthrax, &c. 8. The entirety of the disturbances constitutes surgical fevers. To prevent these terrible consequences of operations, M. Maisonneuve suggests the adoption of the subcutaneous method, and the employment of all means of preventing putrefactive processes.

The Cause of Colour-blindness.—In a paper, published in one of the American Medical Journals, Dr. M. A. Pallen states that this condition is divided into two classes, viz., *Achromatopsy*, or an insensibility of the eye to colours, and *Dischromatopsia*, which is a species of insensibility to colours. Of these, one is hereditary; the other is acquired and often subjective. Dr. Pallen believes that the colour-blindness depends upon some abnormality of the vitreous humour, whose function he believes to be the correction of prismatic refraction. It is well known that the vitreous humour is composed of a great number of irregular-shaped compartments, containing gelatinous-like fluid. These cells are separated by septa, and it is the disturbance or abnormal condition of these septa to which Dr. Pallen attributes the irregular refraction which gives rise to colour-blindness.—*Vide The British Medical Journal*, March 16.

Intermittent Fevers produced by Vegetable Organisms.—Some time since, we called attention to Dr. Salisbury's observations, tending to support the theory expressed above. More recently, these ideas have been, in some measure, confirmed by Professor Hannon, of the University of Brussels. In 1843, says M. Hannon, "I studied at the University of Liege; Professor Charles Morsen had created in me such an enthusiasm in the study of the fresh water algæ, that the windows and mantelpiece of my chamber were encumbered with plates filled with *vaucheria*, *oscillatoria*, and *confervæ*. My preceptor said to me: 'Take care at the period of their fructification, for the spores of the algæ give intermittent fever. I have had it every time I have studied them too closely.' As I cultivated my algæ in pure water, and not in the water of the marsh where I had gathered them, I did not attach any importance to his remark. I suffered for my carelessness a month later, at the period of their fructification. I was taken with shivering; my teeth chattered; I had the fever, which lasted six weeks."—*Ibid.* February 23.

Hyposulphites in Dysentery.—M. Paul records some cases of dysentery, in which great relief was given to the patient by the injection of solution of hyposulphite of soda. This substance also completely removed all smell.—*Vide Bulletin de Thérapeutique*.

Quantity of Red Globules in the Blood.—Signor Mantegazza, of Pavia, has undertaken a number of researches on this subject. Having constructed a new form of instrument for estimating the number of the red corpuscles, he arrives at several important conclusions, of which the following are a few:—
1. The maximum number of red corpuscles in the blood of a healthy man is 5,625,000 per cubic millimetre of blood; the minimum (found in the blood of an anæmic woman) being 2,250,000 in the same volume. 2. The colour of the face and lips does not indicate the presence of a large proportion of red globules in the blood. 3. Urea, injected into the veins, rapidly diminishes the quantity of blood globules, in seven days reducing the number to about one-fifth of the usual quantity. 4. The proportion of the corpuscles in rabbits is nearly the same as that of man. 5. The fœtal rabbit has a larger proportion of red corpuscles than its parent.

Medical Products of the Pine.—It is stated, by the *Chemical News*, that these products are now being much used in Paris. We cannot vouch for the reported therapeutic importance of these substances, but, as it may

interest our readers, we quote our contemporary's observations:—"Vegetable wadding preserves all the properties of the pine; it evolves an aroma eminently wholesome. Dr. Schillbach recommends it as a most harmless but efficacious remedy in cases of catarrh, bronchitis, asthma, sore throat, etc. Raw vegetable wool is one-half cheaper than the ordinary wool mattresses. Those stuffed with this wool do not attract humidity; its odour and the ozone, due to its resinous principles, keep off or kill the insects. Schmidt-Missler's flannel, by reason of the resin, the tannin, and the formic acid it contains, aids the exercise of the important functions of respiration, absorption, and perspiration, in a greater degree than ordinary flannel. It is, at the same time, a preservative and corrective agent, which merits to become popular in Europe, as it is in Germany, and can be woven into any of the forms for which flannel is used, such as mittens, waistcoats, drawers, socks, &c. Etherated pine-oil, employed in friction, has given unexpected results; in the first commencement of paralysis and apoplexy, in the case of recent burns, etc."

The Formation of Cells in Animal Tissues.—This long-debated question does not appear likely to be answered satisfactorily by the recent researches of Dr. E. Montgomery. Dr. Montgomery lately presented a paper to the Royal Society on the above subject, and in it he endeavoured to prove that the formation of the animal cell is purely a physical process. This he believes to have demonstrated experimentally. The following experiment is the one which most strongly supports his opinions:—"When to myeline, in its dry amorphous state, water is added, slender tubes are seen to shoot forth from all free margins. These are sometimes wonderfully like nerve-tubes; they are most flexible and plastic. From this curious tendency of shooting forth in a rectilinear direction, it was inferred that a crystallising force must be at work. To counteract this tendency, and to oblige the substance to crystallise into globules, it was intimately mixed with white of egg. The result was most perfect. Instead of tubes, splendid clear globules, layer after layer, were formed, resembling closely those of the crystalline lens formed under similar conditions. The remaining task was comparatively an easy one. By mixing the myeline with blood serum, globules were obtained, showing the most lively molecular motion.—*Vide Proceedings of the Royal Society.*

The Arrangement of the Lymphatics.—In a note presented to the French Academy M. Robin described the appearance of the lymphatics in Torpedos (animals which are admirably adapted for researches on the lymphatic system). In this class of fishes generally the network forming the origin of the lymphatics are directly applied against the capillary blood-vessels. Concerning the section of a capillary, the lymphatic vessel forms a canal which embraces one half, two-thirds, or even three-fourths of the circumference of this vessel. The lymphatic, in fact, represents a canal which has a proper wall only on one side; for the rest of its extent it is bounded by the capillary—at least, the proper coat of the lymphatic adheres so to the capillary that it is impossible to distinguish this portion of it. Thus it may be seen that the lymphatic vessels are closely applied to the capillary vessels, and the same position is observed as regards the larger arterial vessels also. From the numerous anatomical facts which he adduces, M. Robin is led to conclude

that the chief use of the lymphatics is to charge themselves with the excess of that portion of the blood plasma which reaches and issues from the capillaries at each beat of the heart.—Vide *Comptes Rendus*, January 7.

The Brain of the Cuttle-fish.—Mr. Lockhart Clarke, F.R.S., has published a valuable memoir on the optic lobes of the cuttle-fish. In this he gives a general account of the brain of this creature. The brain, he says, consists of several ganglia closely aggregated round the upper part of the œsophagus. The foremost or pharyngeal ganglia, which is much the smallest, is bilobed, and somewhat quadrangular. The next is a large bilobed ganglia, which forms the roof of the canal for the œsophagus. Beneath the œsophagus is another large and broad mass, which is connected on each side with the supra-œsophageal masses by bands that complete the œsophageal ring. From each side of the cephalic mass springs a thick optic peduncle which ends in the optic lobe. Strange to say, each optic lobe is larger than all the other cerebral masses taken together. It resembles the human kidney. "It is completely enveloped in a thick layer of optic nerves, disposed in flattened bands which issue from all parts of its substance, and pierced to the back of the eye in a fan-shaped expansion, the upper and lower bands crossing each other in their course. The substance of each lobe consists of two distinct portions, which differ from each other entirely in appearance. The outer portion resembles a very thin rind or shell, is extremely delicate, and is very easily torn from the cerebral substance which it encloses. It consists of three layers—an external, an internal, and a middle pale and broader layer, containing thin and concentric bands of fibres.

The Accoucheur's Air-pump.—M. Kaufmann says that the difficulties of parturition are often caused by the existence of a vacuum, which prevents the expulsion of the child. He therefore proposes to employ an air syringe with which to prevent so unfortunate an obstruction. This will no doubt astonish some of our medical readers.

Tobacco Smoking Injurious to the Eyes.—In a recent number (February 15) of the *Bulletin de Thérapeutique*, M. Viardin describes two cases of serious eye affection (Amblyopia) resulting from the habit of smoking. M. Viardin at once, on learning the habits of the patients, induced them to smoke a much smaller quantity of tobacco than usual, and the result was a complete restoration of vision in a few weeks from the date of their application.

Ergotine after Operations.—M. Labat asserts that ergotine should be given after every surgical operation. He says that it completely prevents the development of morbid products likely to be detrimental.

Action of the Curara Poison on the Human Body.—When not given in absolutely poisonous doses, the effects of curara on the human system are peculiar, and have been quite recently studied by MM. Voisin and Liouville. The therapeutic effects appear to be twofold, according to the dose administered. The doses producing these effects vary from 5 centigrammes to 135 milligrammes. In these doses the substance was administered (after filtration) by subcutaneous injection. The rapidity of the appearance of the effects and their intensity were proportionate to the dose. They have been divided by the authors into two categories. The first of these is characterised by a disturbance of vision, a sense of weight in the eyelids, which

are kept half closed, and a feeling of obstruction in the frontal region. The second is characterised by diplopia, dilatation of the pupils, and subsequent heaviness of the head, tending to sleep and drowsiness. The second effects are produced by doses of from 5 to 9 centigrammes, and the first by doses of from 10 to 135 milligrammes.

Influence of Respiration on the Circulation.—Dr. Burdon-Sanderson, who delivered the Croonian Lecture at the Royal Society on March 7, put forward opinions relative to the influence of the respiratory movements over the movement of the blood in the great vessels, which are different from those stated in most of the existing text-books on physiology. Dr. Sanderson stated that so long as the air passages are open, each expansion of the chest is followed by increase of arterial tension, so that the effect of inspiration is to increase alike the pace and frequency of the heart's contraction. When, however, the respiratory apertures are closed, as in suffocation, the relations are reversed, the pressure in the arterial system being then highest in expiration, and *vice versa*.

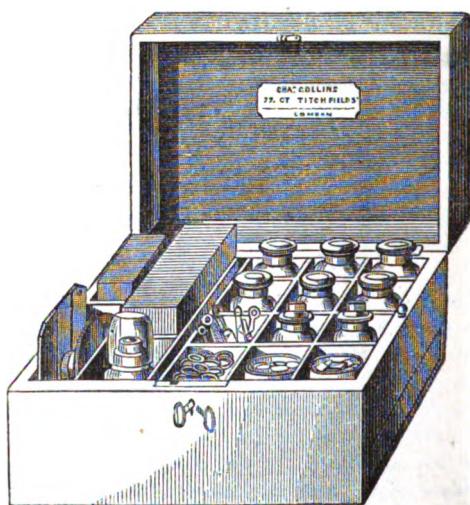
MICROSCOPY.

A Diaphragm Eye-piece.—This ingenious and useful contrivance, the invention of Henry J. Slack, Esq., F.G.S., has been lately described to the Microscopical Society. Mr. Slack found that in viewing small objects by transmitted light, it frequently happens that there is such a large field of light external to the object, that not only are small details of structure obscured, but the eye is wearied by the influence of the luminous stream. To prevent this he requested Mr. Ross to adjust four movable shutters, so that an A eye-piece might be susceptible of all the changes in the form and size of its field that different objects would require. This change was soon effected. Mr. Slack has, therefore, provided microscopists with an eye-piece which will be found useful in research, and will tend to protect the eye from the injurious influence of the stream of bright light which usually falls upon it.

Wire-spring Clip.—Those who have used Dr. Maddox's wire-spring clip will be glad to learn that an improved form of it was exhibited by Mr. Jabez Hogg some time since, at a meeting of the Microscopical Society. It differs from the original form in having the point, which presses on the covering-glass, protected by a little disc of leather. The advantages of this addition are manifold. The pressure of the spring is distributed uniformly over the covering-glass, and this latter is therefore not only less likely to be broken, but less liable to disturbance from its proper position. They are sold by all makers. Those we have seen were shown us by Mr. Charles Collins.

The Amateur's "Mounting" Case.—This is a case prepared by Mr. Collins, of Great Titchfield Street, and of which we give an illustration. It is intended for the use of those whose microscopic pursuits are of a general character, and is, so far as we can see, admirably adapted to the

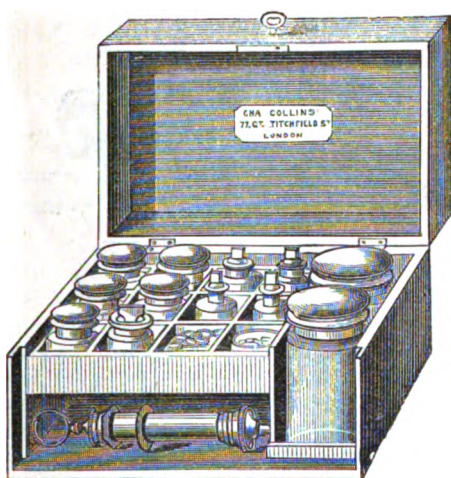
purposes for which it is devised. It consists of a handsome polished deal case, with lock and key, and is divided into several compartments, in which are placed all the appliances required by the general microscopist. To enumerate the contents would be useless, but we may mention some of the apparatus supplied. These are: A spirit lamp, mounting table, turning table for cells, a set of wire-spring clips, bottles containing all the fluids (balsam, turpentine, gold size, &c.), tin cells, ground-glass slides, thin covering glass, &c. The whole case is so compact, so ingeniously arranged, and so full of all the materials required in mounting objects, that we have no doubt it will meet with the approval of our readers.



THE AMATEUR'S "MOUNTING" CASE.

The Student's "Mounting" Case.—This case has been prepared by Mr. Collins at our suggestion, and we venture to think that it will meet the wants of those who are engaged in the study of animal tissues. The study of human histology is so different from that in which most microscopists are engaged, that it requires a set of contrivances and apparatus for investigation quite distinct from those generally employed in microscopic observation. The student is often at a loss to know what appliances he requires for his researches, and not unfrequently when this first difficulty is surmounted, he is ignorant as to where he may procure these appliances; this last obstacle, being enhanced by the fact that he must go from one optician's to another to get together his materials. Finally, he must bring a prescription to a chemist for his injecting fluids. Now, we know, from our own experience, that the earnest medical student has very little leisure at his disposal, and we have therefore caused to be put together the several fluids and instruments which we believe to be essential to his microscopical inquiries. The woodcut to some extent shows the nature of the new case;

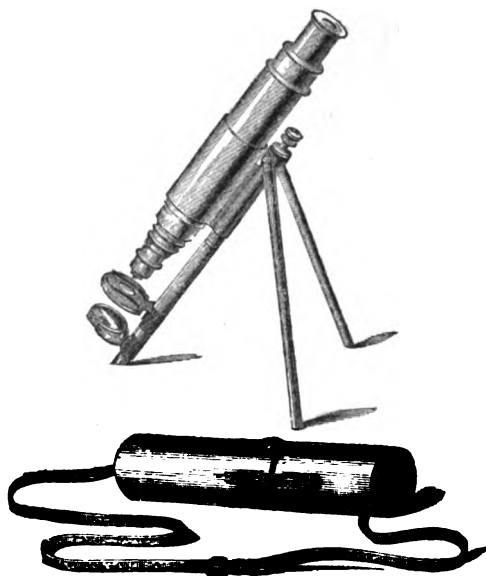
which is a square polished deal box, with lock and key. The two large bottles to the right contain the blue and scarlet transparent injecting-fluids, recommended by Dr. Beale, and which we have found extremely useful. The smaller bottles contain glycerine, marine glue, asphalt, Dean's fluid, balsam, turpentine, chromic acid, carmine fluid, bichromate of potash, solution of caustic potash, and acetic acid. The two latter bottles are provided with stoppers which project nearly to the bottom, and thus enable the student without loss of time to obtain a drop of the reagent he requires. Most of the other bottles, too, have projections from their stoppers for a like purpose. In the lower part of the case is seen a syringe, with stop-cock and nozzles, glass slides, razor in fixed handle, Maddox's spring clips, covering-glass, tin cells, American letter clips (for stopping up vessels), curved needles, silk, &c. Of course it is quite possible that, in very complex investigations, other apparatus than those mentioned may be required; but we think that, for all the purposes of ordinary investigation, the student will find all that he wants in this case.



DR. LAWSON'S STUDENT'S "MOUNTING" CASE.

The Travelling Microscope.—Mr. Moginie, of the firm of Messrs. Baker of Holborn, has just devised the microscope represented in p.226, and they term it the travelling microscope. It is intended to be placed in the telescope case (in the cut) and to be slung upon the shoulders like a field glass. The three legs form a solid firm support, and being hollow in the interior are employed to contain dipping tube, &c. The rough adjustment is telescopic, but the fine adjustment is provided for by a spring and screw placed on the upper part of the central or largest leg of the tripod; this adjustment, so far as we have seen, is uniform and efficient. When it is required to place the microscope in the vertical position, three smaller legs, enclosed in one of the tripod legs, come out, and may be screwed into the instrument, producing a tolerably

firm foot. There is a small mirror and stage. The instrument is provided with the universal screw, so that the objectives of one's usual microscope may be attached to it.



THE TRAVELLING MICROSCOPE.

An ingenious Pond-stick, which will be found very useful by those engaged in collecting infusoria, &c., from ponds, has been constructed by Messrs. Baker. In appearance it resembles an ordinary walking-stick. When the ferrule is unscrewed a second stick may be drawn out from within the first, thus doubling the length. To the end of this is attached a brass ring, and into this can be screwed a dipping bottle. These bottles may be had of various sizes, and as the glass neck is worked into a screw they can readily be attached to the ring.

The Microscopist's Air-pump.—Most of the air-pumps in use by microscopists are large, inconvenient, and expensive. Mr. Baker has, however, constructed one which is especially intended for the preparation of microscopic objects, and which appears likely to prove useful. Beneath a solid table is fixed the pump in the form of a brass syringe. This communicates by an aperture with a smooth metallic plate fixed on the table. When required for use the object is laid on this plate and is covered with an oblong glass box whose edges are ground and greased (being thus rendered air-tight). The syringe being now worked, the air is rapidly removed. The plan was devised by Mr. W. Mognie.

PHOTOGRAPHY.

Sun-Painting in oil colours.—Mr. Pouncy of Dorchester read a paper under this title at a recent meeting of the Inventors' Institute, wherein he described certain improvements in his process of permanent printing in photography calculated to widen its sphere of application, and give it more practical value and interest. The sensitive medium used, is that first introduced in connection with photographic experiments, viz., bitumen of Judea, which is dissolved in turpentine, or benzole, with which pigments ground in oil are mixed so as to produce any given colour, tint or shade. Brushed over a thin sheet of translucent paper and dried in the dark-room it is then exposed to the action of natural, or some powerful artificial, light under a negative, until the actinic influence renders the parts to which it has had access in various degrees proportionate to its degrees of action insoluble in the original solvent, the application of which of course produces the picture. This is then transferred by pressure in a lithographic press to cardboard, canvas, wood, stone, or when ceramic colours are used by hand pressure only, to potter's "biscuit" and burnt in. Mr. Pouncy illustrated his paper with a great variety of specimens and went through the different manipulatory processes with great ease and certainty.

The Latent Image.—We have chronicled from time to time experiments intended to demonstrate the true nature of the photographic image, and last did so in connection with the efforts of Mr. Carey Lea published in *The British Journal of Photography*. A well known French experimentalist, M. Davanne, writing upon the theoretical researches of the above-mentioned gentleman (and those of Major Russell and MM. Poitevin and Vogel) says although Mr. Carey Lea has certainly cleared up one important controversial point, viz. the sensitiveness of iodide of silver, when pure, to the action of light, yet he has done nothing calculated to show definitely whether the latent image is due to purely chemical or to purely physical action, and adds "In presence of light the iodide of silver discovers a tendency to lose a portion of the iodine, especially where it is connected with a body which is capable of absorbing it. It seems therefore that light not only modifies the physical condition of the iodide, but brings about its *chemical* decomposition, having determined the elimination of iodine." M. Davanne is therefore strongly inclined to attribute the formation of the photographic image rather to chemical, than to physical conditions. In connection with this subject he also asks those who uphold the physical theory, how they explain a curious fact recently made known to him by M. Magny, who having put aside a negative as useless, from its want of detail in the less exposed portions of the plate found after it had been in darkness for about six months, that well defined details had positively become developed by the continued slow decomposition of the iodide of silver. Commenting on this statement, the Paris correspondent of the *British Journal of Photography* says: "Without wishing to shirk the question put by M. Davanne, I would suggest that it is not philosophical to assume that 'time can produce the same action as light,' because, had that plate been exposed to light six months before it was developed the lines and half-tones would not have appeared, and if it had been

kept without the action of the developer for six months after the exposure the lines would have been equally invisible. It was not time, which produced the image, and I think the question of physical *versus* chemical action is in no way touched by the fact. It seems to me that the iodide of silver on the plate was altered by light so as to be acted upon by the developer; that the developing action was not continued sufficiently long *under the inspection* of the operator for all the details to be produced, but the plate being considered useless was put away with some of the developer adhering to it, which, acting slowly upon the already altered iodide of silver, gradually continued the light's action. This fact proves, I think, if it proves anything, that however weak the action of light may be upon a plate, it may be rendered visible if you develop long enough." It is giving M. Davanne excessively little credit to suppose that he overlooked the above extremely simple explanation of M. Magny's "curious fact." We think it exceedingly improbable that M. Davanne did not satisfy himself upon the above points before he plunged into print and asked for an explanation of a very different nature than that based upon the above assumption.

The Tannin Process.—Better pictures than those produced by the Tannin process we have not met with. Therefore, in common with most other photographers, we were grieved and annoyed to read in the *Journal of the Photographic Society* an ill-judged editorial article strongly condemnatory of the process, sneering at its author, and insulting the many able and eminent amateur and professional photographers, who practise it. The following quotation, as a specimen, will, we fear, not convey a very favourable impression of its author's good-nature or impartiality. "*To clear the ground of rubbish is at all times a step in the right direction. For this reason the almost total abandonment of the tannin process must result in good. This process has vexed and irritated photographers ever since its first appearance. The best pictures ever exhibited by it have been of that mediocre class which pleases none but those most easily pleased. Much time would have been saved to amateurs if the process had remained in the chaos from which it apparently sprung!*" The editor of one of our contemporaries says: "We are a little curious to know how such earnest workers as Messrs. Mathew Whiting, Le Neve Foster, Jabez Hughes, Warwick, King, Major Russell, and numerous other gentlemen, whose names have been honourably and intimately associated with the practice of the tannin process relish the impertinences thus flung at them." Several gentlemen who were on the Council of the Society sent in their resignation in consequence of this uncalled-for attack, protesting against the admission of articles into the Society's *Journal*, which are injurious to its character and to the best interests of the Society; and a letter from one gentleman whose name was introduced in the article as antagonistic to the tannin process has been published, in which he says that he has abandoned every other process and given in his adhesion to the tannin as the best he can employ.

Hardness as a defect in Photographs, has received attention at a meeting of the South London Photographic Society in a paper read by one of its Vice-Presidents, Mr. A. H. Wall, who pointed out that the excessive intensity of the illumination given by a lens must necessarily produce images very different from those seen by the human eye. The smallness of the

aperture or pupil, the character of the humours composing the lenses and the field (or retina) covered, when compared with the photographic lens and camera, all showed how widely different were the conditions under which the two kinds of images were relatively formed. Looking at natural objects with the naked eye and then looking at them as thrown by a lens on the photographer's focussing screen was as if the objects had been suddenly conveyed into a purer and more strongly illuminated atmosphere. The lights, shadows, and colours appeared greatly more intense, minute detail became more prominently and sharply defined, varieties and degrees of difference in texture largely disappeared, distant objects seemed nearer; and however charming the effects thus seen might be on the ground glass, they were productive of anything but a proper natural effect in the finished photographs. This was due, Mr. Wall believed, to the condensation of an excessive amount of light by large lenses constructed with a view to accelerating the exposure of the plate. The remedy Mr. Wall proposed was the adoption of lenses of longer focus with smaller apertures or stops and with the use of chemicals and other conditions calculated to render the exposures as short as, under such circumstances, was possible. A very animated discussion followed the paper, and various views were advanced, most of them being more or less favourable to the opinions above expressed.

Mr. Dallmeyer's "New" Portrait Lens.—This lens is so constructed as to give its user the option of either producing a sharp image or one softened, or blurred, by being put more or less out of focus. Some writers have argued as if this eminent optician, by introducing such a lens, advocated spherical aberration as an element of artistic success in photographing. We suspect the simple truth to be that Mr. Dallmeyer only desired to produce a lens for which there appeared to be a growing demand in the optical market.

Photography and Electricity.—Mr. William H. Harrison informs us that at the present time more than one philosopher of eminence is experimenting photographically on comparatively untrodden ground in connection with the rays thrown out by electricity in passing through vacuum tubes, such rays being rich in photogenic power.

Photographs of Brass Rubbing.—Mr. O. G. Rylander has recently given attention to a new photographic application, by which a large number of copies may be obtained from the rubbings from old brasses, it being his intention, we believe, to publish them in a volume, for which purpose he solicits communications from those who may have a collection of such rubbings. Mr. Rylander's address is 129 Malden Road, Kentish Town. A brass rubbing is effected by pressing a sheet of white paper in close contact with the monumental tablet and rubbing the upper surface with a small cake of shoemaker's "heel ball," while care must be taken that the paper be not displaced during the operation. By these means the raised parts are blackened and rendered opaque and the white parts are more transparent. By using this as a negative on paper sensitive to light, a print is obtained in which the lines are black on a white ground.

PHYSICS.

Changes of Temperature produced by Mixing different Liquids.—MM. Bussy and Buignet, to whose united researches we have already directed attention in an earlier number of this Review, have presented a second memoir to the French Academy, on the above interesting phenomenon. They have arrived at the following conclusions:—1. In all the cases under examination, with one sole exception, the calorific capacity of the mixture is a little superior to the mean capacity of the elements. 2. By a singular opposition, the liquids for which the increase of bulk is the most considerable are exactly those which develop most heat at the moment of their union, such as ether and chloroform, alcohol and water, sulphuric acid and water. Meanwhile, the only instance hitherto noticed of a diminution of bulk is the mixture of *chloroform* and *sulphide of carbon*, at the same time the decrease of temperature taking place at the moment of the union. 3. Independently of the loss of heat resulting from the changes of volume, there exists a cause which produces alone an absorption of heat—an absorption which can be sometimes equal, and even superior, to the heat given out by the combination of the liquids.—*Comptes Rendus*, February 25.

Frozen Aërated Waters.—Mr. Tomlinson, of King's College, who is one of our most indefatigable students of Natural Philosophy, has written to our contemporary, the *Chemical News*, explaining the curious phenomena resulting from the freezing of water, saturated with carbonic acid. He gives the following account of one of his first experiments:—During the recent cold weather I impregnated with carbonic acid, distilled water contained in eight-ounce and other phials, which were then corked and exposed to the air at temperatures ranging between 23° and 30° F. The first action of the cold was to produce long needles of clear transparent ice, as thick as the little finger, occupying about the centre of the bottle, in some cases parallel with the sides, in others at an angle thereto. The further action of the cold was to enclose these transparent crystals in opaque ice, to thrust out the cork and break the bottle. In one case the bottom of the bottle was forced out; in others the sides were cracked, and the cracks ran in lines from top to bottom, nearly parallel with the long axis of the bottle. Opaque ice filled the neck, and even overflowed, so that the ejection of the cork, the fracture of the bottle, and the overflow of the ice, were simultaneous acts.

New Form of Telegraphy.—An invention for the transmission of despatches by an automatic electro-chemical method has been devised by MM. Vavin and Fribourg. Its object is to utilise all the velocity of the current on telegraphic lines. The Abbé Moigno, who has called attention to it in England, gives the following description of it:—It consists in the distribution of the current through as many small wires, very short and isolated, as there are signals to be transmitted, all the while only employing one wire on the main line. Each of these small isolated wires communicates, on the one hand, with a metallic plate, of a particular form, fixed in gutta-percha; and, on the other, with a metallic division of a disc, which is also formed of an insulating substance. A group of eleven of those small laminæ form a

sort of cypher, which will give all the letters of the alphabet by the suppression of certain portions of the fundamental form. "Now," says the Abbé, "suppose rows of these compound characters to be placed on a sheet of prepared paper of a metallic nature, the words of the telegram to be sent are written on them with isolating ink, leaving the other parts of the small 'stereotyped' blocks untouched. The consequence is that the current is intercepted at every point touched by the ink, and a letter is imprinted on the prepared paper at the other end of the line where the telegram is to be received."

The Magnetic Polarity of Rifles.—Mr. J. Spiller has lately made some very interesting observations respecting the magnetic power assumed by rifles. He finds that all the long Enfield barrels of the arms in the possession of the volunteers of his company exhibit magnetic polarity as the result of the violent and repeated concussions attending their discharge in a direction parallel to the magnetic meridian. The Royal Arsenal range runs nearly north and south, and the rifles, when in use, are always pointed either due north or a few degrees towards the west—in fact, nearly in the direction indicated by a compass needle—so that the repeated shocks brought about by the explosion of the powder may, Mr. Spiller thinks, be considered equivalent to so many hard blows from a hammer, which, as is well known, have a similar effect. Mr. Spiller goes on to say that the magnetic character appears to be permanent, which would not be the case if the gun-barrels were of the softest description of malleable iron, and the region of the breech is, in every instance, possessed of north polarity, since it strongly attracts the south pole of the compass needle. These effects should not be noticed at all, or only to an inferior degree, in arms ordinarily fired in directions east and west; and I imagine that by reversing our usual practice, if it were possible, and firing towards the south, the indications of polarity would be changed.

Electric Guns.—At a late meeting of the Society of Natural Sciences of Seine-et-Oise, M. De Brettes exhibited a rifle on the Fiobert system, and which is fired by means of electricity. This new invention, with which the Emperor appears to be much pleased, has the following characters:—Two small electric batteries are enclosed in the stock, their conducting wires arrive at the surface of the breech, and can be put in communication with the extremity of a platinum wire, which traverses the cartridge. A simple pressure of the finger upon the trigger closes the electric circuit; the current passes; the platinum wire becomes at once redhot, and inflames the powder which surrounds it. The cartridges prepared for the needle gun carry their own priming, and a shock might inflame them; the cases are thus liable to explode, and deprive the troops of their ammunition. With the new system this danger is impossible. It can, as the expense is trifling, be easily applied to guns of the ancient model. This ingenious weapon does not, however, seem likely to come into general use. Though exhibited by M. De Brettes, it was invented by M. Trouvé.—*Vide French Correspondence of Chemical News.*

Elongation of Electric Conductors.—Mr. E. Edlund has noticed a very interesting phenomenon in connection with the passage of an electric current along a wire conductor. He has found that when a current is passing

along a wire, that this latter becomes elongated to a greater extent than would be explained by the increase of temperature in the wire. This is his mode of experimenting:—Taking a wire the amount of whose expansion by heat is known with perfect exactitude, a current is passed through, and the elongation of the wire is measured; if its temperature at the moment be known, it will be seen whether its elongation is in accordance with this temperature, or is greater. In order to estimate the temperature, M. Edlund measures the electric conductivity of the wire, and having arrived at this he deduces the temperature from it. This process of investigation always proves that the temperature is lower than would explain the elongation of the wire. Hence he concludes that the elongation is not the result of heat. It must therefore be produced by the passing current.—Vide Poggendorff's *Annalen*, No. 9.

The Physics of the Fire-damp Indicator.—One of the latest forms of Mr. Ansell's Fire-damp Indicator is thus described by a contemporary:—It consists of an iron funnel, provided with an iron U-tube, the end of which is closed by a piece of glass tube, fixed in brass, to which one pole of a battery is attached; the upper part of this glass tube carries a brass collar, through which passes an adjusting screw, to the lower end of which is fastened a piece of copper wire with a platinum point. Mercury is poured into the iron funnel till it rises in the glass tube to a convenient height. This mercury is allowed to find its level by the opening of a valve, when setting the instrument. The septum is a tile of Wedgwood's ware, and closes the open part of the funnel, good sealing wax being the best cement for securing it in its place. The other battery wire is connected with the instrument, so that, if diffusion take place, the mercury is pressed up against the platinum point, and thus communication is established. Mr. Ansell has found that this instrument gives warning in four seconds, if the mixture of gas be still below the point of explosion; but, by adjusting the point so that there is not more than the thickness of a shilling between it and the mercury, a dangerous irruption may make itself known in two seconds.

A Cheap and Ingenious Ice Machine.—M. Tonelli, says the Abbé Moigno has just devised an ice-making machine which bids fair to become very popular in this country, since it is convenient, cheap, and efficient. The inventor calls it the "*glacier roulante*." It is a simple metallic cylinder mounted on a foot. The salt of soda and the salt of ammonia are added in two operations, the smaller cylinder containing the water to be frozen is introduced into the interior, and the orifice is closed by an india-rubber disc, and then by a cover fastened with a catch; the cylinder is then placed in a sac, or case of cloth, and it is made to roll on the table with a slight oscillatory movement given by the hand. After a lapse of ten minutes, the water in the interior of the cylinder becomes a beautiful cylinder of ice. Nothing is more simple, more economical, or more efficacious than the new "*glacier roulante*," which costs 10 fr., and gives us, moreover, what could not hitherto be obtained with an apparatus containing freezing mixtures—the means of freezing a decanter of water or a bottle of champagne. The apparatus, in a case, packed for travelling, with 20 kilogrammes of refrigerating materials and a measure, costs, at present, only 1*l*.

A New Meteorite.—It is stated that some very large and heavy meteorites, which fell during last summer in Hungary, have been recently examined. The circumstances under which the fall occurred are interesting, the sky being quite clear, between four and five in the afternoon. At the time of the fall, a violent detonation was heard, similar to that produced by the simultaneous discharge of a hundred cannons. The meteorites appeared as a greyish cloud, about the size of the sun's disc, uniting on all sides columns of greyish smoke, but without a trace of luminous appearance. Two or three minutes after this appearance, a noise was heard like that of a multitude of stones rattling together; this lasted for ten or fifteen minutes, and, after it, the fall of stones took place. Several eye-witnesses, at localities six to twelve Austrian miles distant, describe the meteor as having presented the appearance of a yellow and orange luminous globe, followed by a train bordered with ultramarine blue. About sixty stones were collected, and were found to possess the usual characters of meteors, being covered also with a layer of black enamel. The heaviest of these weighed 550 lbs.; it was broken in two by the violence of the shock, and from the violence with which it fell to the earth, it passed into the soil to the depth of about eleven Austrian feet, in this way forming a hole or pit nearly four feet wide. At a temperature of 20° Reaumur, they had a specific gravity of 3.520. When first found, the meteorites were quite hot, and some of them retained their heat for several days.

The Detection of "Tears" in Lenses.—The presence, in lenses, of spots of a different refracting power from the rest of the lenses, is a serious difficulty in optical experimentation. It is, therefore, interesting to know that Herr A. Töpler has discovered a very useful method of detecting these portions [tears] in lenses. The mode which this physicist adopts is as follows:—The light proceeding from a bright lamp, through the aperture of a small shade, falls upon a system of lenses, which should be as achromatic and aplanatic as possible. The transmitted light concentrates in a focus, at a distance of from ten to twenty-five feet on the other side. A simple Keplerian telescope of two lenses is so set up that its optical axis coincides with that of the system of lenses above mentioned, and that the focus of the rays issuing from the system of lenses lies in front of the object-glass of the telescope. The telescope, moreover, is so drawn out that the rays issuing from the eye-piece have their point of junction at the pupil of the eye, and hence project on the retina the image of an uniformly illuminated field of view. If a screen be laterally pushed in front of the object-glass of the telescope, as soon as its edge passes by the place of the focus the field of view will at once become dark; if, either in the glass of the system of lenses in question, or in media which are placed before or behind it, there are places of different densities; some rays will, therefore, be deflected from their path—they will not pass through the focus, and hence will not disappear when the screen is pushed across. These rays then give an image of the "tears" in the dark field of view.

The Optical Analysis of Sound.—Herr A. Töpler has pointed out an improved method of analysing vibrations by an optical method. We cannot here give any adequate explanation of the principle on which his apparatus is employed. We, therefore, commend the reader to the author's paper on

the above subject. It will be found in the *Philosophical Magazine* for January.

Standard Thermometers.—Perhaps there is no instrument which it is of more importance to the meteorologist to have perfectly corrected than the thermometer; yet we learn, from a letter recently addressed to the *Times*, by Mr. H. C. Kay, that even among the instruments of the first London makers there is a great want of uniformity. A correspondent of the *Chemical News*, writing upon the same subject, corroborates Mr. Kay's remarks. Two years ago, he required a first-class *maximum* registering thermometer for scientific purposes, and he applied to Messrs. Negretti and Zambra for a standard instrument, with the Kew certificate. Not having one of them at the time, they sent him one of the instruments with Mr. Glaisher's certificate, which stated that the "reading" was 0.5° too high throughout the range. Some time after, suspecting that the difference was greater than was represented, he made a comparison with some of the Kew certificated instruments, and found the following result:—

Kew instrument. degrees.		Mr. Glaisher's instrument. degrees.
$57\frac{1}{2}$		59
$70\frac{1}{2}$		72
79		$81\frac{1}{2}$

We draw attention to these facts, because they are of serious importance. We trust, therefore, that some arrangements may be come to by which only one certificate shall be allowed, and which shall compel all standard thermometers to be registered.

Vapour Density.—There is now being given a good deal of attention to this subject, especially upon the Continent. M. Deville, who, as well as M. Cahours, has given it especial consideration, considers that the objections which many chemists have to admit that the equivalents of elements and compounds correspond to one and eight volumes, being grounded on analogies, are supported by little better than gratuitous hypotheses. He has, in conjunction with Troost, taken the vapour density of NH_4I , HgI at 350° and 440° , and obtained the numbers 6.49 and 6.38, the density calculated for eight volumes being 6.44.

ZOOLOGY AND COMPARATIVE ANATOMY.

A new Rotifer.—The *Microscopical Journal*, in its analysis of foreign memoirs, often supplies us with valuable and interesting information. Not the least important of the matters recorded in its last chronicle is that which refers to the discovery and description of a new rotifer by Herr Elias Mecz-nikow. This observer states that when examining the under surface of some leaves of the *Nymphaea lutea* at Giessen he discovered a number of white lenticular bodies, which proved on examination to be forms of a new species of rotifer. The adult form of this remarkable species appears when expanded to consist of two nearly equal circular sacs, the anterior of which is open, forming the mouth, and is destitute of any wheel apparatus; it possesses at

the same time a mastax, well-marked water-vessels, and reproductive organs. The young female differs totally from the adult in the possession of a ciliary apparatus, distinct eyes, and also in its free habit of life. The adult male is, as in other rotifers, quite unlike the female. He has a broad ciliated oval extremity, provided with eyes, and apparently a large præ-oral ganglion, while his body gradually tapers to a point posteriorly provided with a few cilia.

New Myriapoda.—Sir John Lubbock, in a paper read before the Linnæan Society at a late meeting, described a new genus of myriapoda, which he thinks ought to be the type of a new order of this class. It is called *Pauropus*, from the circumstance that it possesses far fewer legs than its fellow genera. The author of the paper met with two species, *P. Huxleyi* and *P. pedunculatus*. The first is the type of the genus: it is about $\frac{1}{25}$ of an inch long. It occurs in considerable numbers among dead leaves and in other accumulations of decaying organic substances. Though not exactly sociable in its habits, it exhibits none of that extreme ferocity which characterises the chilopoda. It is very abundant in the author's garden at High Elms. Sir John Lubbock wonders how it has been so long overlooked, but attributes it to the fact that its small size and few legs give it the appearance of some insect larva. The characters of *Pauropus* we cannot afford space for, but they deserve attention, for they are peculiarly exceptional and serve to show that *Pauropus* is allied to the crustacea.

The Fishes of the Amazon.—The district of the Amazon appears to swarm with all forms of organic life. Of the land animals a very able and graphic account has already been given by Mr. Bates, and now Professor Agassiz has given an account of his elaborate investigation of the fish of the Amazon. In a lecture delivered quite recently at New York, Professor Agassiz stated that he found that the Amazon has not one fish in common with any other fresh-water basin; that different parts of the Amazon have fishes peculiar to themselves; and, as an instance of the teeming variety that exists in the Amazon basin, he gave the result of his examination of a small contiguous lake or pool, of only a few hundred square yards, which showed 200 different kinds of fishes, which is three times as many as the Mississippi river can boast. In the Amazon itself he found 2,000 different kinds, and when he began his investigation of the river only 150 were known to exist, and he said that in proportion as he found the larger number the difference between them seem to grow. He proceeded to a general classification of the fishes of the Amazon, and instanced one that might appropriately be called a very peculiar fish, inasmuch as it had the power of walking or creeping on dry land, one having been found five miles from the water, and the Professor himself kept one of them out of water half a day, and on putting it back into its natural element it showed as much of life as if it had never been removed. Moreover, it is an agile fish, worming its way up the inclined plane of the trunk of some old tree that had fallen, and twisting about among the branches, until finally a single shot has brought down a bird and a fish together. Professor Agassiz declared that the Amazon, for a river of turbid water and of so high a temperature, the average being 80 deg., nourishes an extraordinary number of delicious fishes for table use.

Influence of Development in the Production of Race.—M. C. Dareste has just

presented a memoir to the French Academy in which he endeavours to prove that monstrosities, errors in development, may become the starting-point of new races. We do not know whether the learned author is strictly correct in stating that monstrosities are perpetuated in races. If, however, he means that natural variations become the starting point of new races he is merely following in Mr. Darwin's steps. Vide *Comptes Rendus*, March 4.

The Production of Male and Worker Bees.—M. H. Landois has presented, a most interesting note, on this subject, to the French Academy [March 4]. This we translate in part. It is generally supposed, according to the observations of Dzierzon and Von Siebold, that the worker bees spring from eggs, fecundated by the queen that lays them, through the medium of the fluid in her *receptaculum seminis*; whilst the male bees spring from unfecundated eggs. Siebold argues, especially, that the presence of zoosperms in the ova of the worker bees, and their absence in those of the males proves that, in bees at least, the formation of the sexes depends on fecundation. But, says M. Landois, "the eggs from which the worker bees are hatched are placed in very different cells from those in which the eggs from which the males spring are laid. Hence arises the question, Could we, by placing the worker eggs in the cells of the male eggs, cause these eggs to be hatched into males? I have made this experiment on several occasions, at first unsuccessfully, because the bees defeated my efforts by restoring the eggs to their original positions; but afterwards with perfect success. I was surprised to see worker bees hatched from the eggs that would otherwise have been males, and males from those which would have been workers." This fact he proved repeatedly, and he, therefore, concludes that the sex of the insect depends, not upon fecundation or non-fecundation, but upon the conditions under which it is hatched—the food on which it is fed.

The Organs of Parturition in the Kangaroo.—The relations of these parts which were described by Sir Everard Home, in 1795, were re-described by Professor Owen, and by M. Ed. Alix. The latter, in a memoir published some year or eighteen months since, alleged that Sir E. Home's assertion of an aperture, leading from the parturition channel to the cloaca, was correct. This statement, however, was contradicted by Professor Owen, in a communication to the *Comptes Rendus*. In the *Comptes Rendus*, January 15, M. Alix re-asserts that such a condition of parts exists, and he denies that Professor Owen and Cuvier are correct.

The Structure of the Heart in Fishes of the family Gadidæ.—M. Jourdain, who has made a great number of dissections of the hearts of these fishes, shows that the heart of the Gadidæ is an exception to the general rule in fishes. Like the heart of the Batrachian, it is devoid of the vascular element. Extremely fine injections, which were so thoroughly forced along the arteries as to return by the veins, failed to penetrate the walls of the ventricle or the auricle. The aortic bulb alone was found to possess a few slender branches, and these did not extend to the heart properly so-called. These arterioles are derived from the hyodean artery, and the veins open into the hyodean vein. To this absence of vessels in the heart corresponds a peculiar structure of the ventricular walls analogous to that seen in Batrachia. The muscular fibres, instead of forming a dense tissue, are arranged in bundles, and have a series of spaces or trabeculae, which consti-

tute a sort of areolar or spongy tissue. What is the object of this? It is a substitute for capillaries. At each dilatation of the ventricle, the blood rushes into all these irregular cavities, thus providing for the nutrition of the muscle; whilst, at each contraction, it is as rapidly expelled.

The Development of Amphioxus lanceolatus has been well described by Herr A. Kovalevsky, in a paper in the *Archives des Sciences*, and which is translated in the *Annals of Natural History* for January. It would be quite impossible to give even an abstract of his observations, they are stated in such a condensed manner, and consist so exclusively of facts. Our readers are aware how important it is to have the development of this aberrant creature worked out, and will consult the paper for themselves.

Spontaneous Generation.—M. Donné comes forward once more as the supporter of spontaneous generation, and the opponent of the Pasteur. He quoted the following experiment in support of his opinions:—I took some hen-eggs, and, having made a minute aperture, I introduced a needle previously brought to a red heat, and allowed about a third of the contents to escape. I filled the cavity thus produced with boiling distilled water, and closed the aperture hermetically with wax. The eggs were then left exposed to a temperature of from 17° to 24° centigrade. Five days subsequently, I raised the wax seal, and, having examined the contents of the egg, found it swarming with vibriones." Whence, asks M. Donné, came the germs of the vibriones? It is impossible to suppose they were originally in the egg, for M. Donné has shown that in eggs which decompose spontaneously they are not present. It is equally difficult to imagine that they were introduced in the boiling distilled water. To us (Ed. P. S. R.) there appears to be this objection to the experiment:—In removing a portion of the egg-contents, and introducing the water, there was nothing to prevent the introduction of the atmospheric air, and, therefore, of organic germs also. See *Comptes Rendus*, January 7.

One of the causes of Silk-worm Disease.—On the 31st of December, M. Béchamp stated to the Academy that his experiments during the summer disclosed one of the sources of silk-worm disease. He took a number of worms from good healthy eggs, and divided them into two batches. One of these he fed with carefully dried mulberry leaves, and to the other he gave leaves highly charged with moisture. He found that all those of the batch fed with dried leaves passed through their metamorphoses; whilst those in the other series perished. Hence, he supposes, leaves charged with moisture to be one of the causes of the silk-worm disease. In those specimens fed on the undried, unprepared leaves, he found the peculiar pebrine corpuscles abundant.

The Muscular Force of Insects.—M. Plateau, whose various researches on this subject we have already called attention to, has replied to one of the objections raised against his comparisons. It will be remembered that M. Plateau illustrated the enormous relative muscular power of the insect by contrasting it with the horse. This comparison was objected to on the ground that the horse has only four legs, while the insect has six. To this M. Plateau replies, that, of those six feet, only the two front and the two hind legs are engaged in the maximum effort of traction, the two others being clearly perpendicular to the direction in which the traction is exerted. *Comptes Rendus*, December 24.

The Development of the Hydrozoa.—In an important memoir on the structure of certain of the hydrozoa, Herr Reichert denies that these animals can be compared with the early phases of the vertebrate ovum. In one of his tabulated conclusions, he says, "the comparison of the hollow body of the hydrozoa to the first stages of development of the organism of the higher vertebrata undertaken by Huxley, and afterwards by Kölliker, has no foundation, in fact; it even proceeds from erroneous suppositions, both as to the nature and signification of the first foundation of the vertebrate animal, and with regard to the structure of the body of the hydrozoa." This is a very decided assertion on the part of Professor Reichert, and we confess that we see some difficulty in the way of its acceptance.

The Circulation of Helix Pomatia.—On this point an extremely valuable paper has been published by Mr. C. Robertson, Demonstrator at Oxford. Mr. Robertson states that he has proved the existence of a general capillary system of blood-vessels in this animal. We, ourselves, have not been able to discern such a condition of parts in *Limax maximus*. Dr. Robertson's memoir is an important contribution to molluscan anatomy.—Vide *Annals of Natural History*, January.

VENUS'S FLOWER-BASKET (*EUPLECTELLA*).

BY DR. J. E. GRAY, F.R.S., V.P.Z.S., F.L.S., &c.



IT is a truism that every created object is beautiful when properly examined. Even the toad has a "jewel in his head." But there are some objects, which from the symmetry of their form, the neatness of their structure, and the beauty of the material of which they are composed, attract the attention and excite the curiosity of the most inattentive. The Venus's flower-basket from the Philippines, which is now to be seen in most of the shops of the dealers in objects of Natural History and in almost every collection, is a production that combines all these attributes of beauty and is admired by all.

The Venus's flower-basket, *Euplectella*, may be shortly described thus: as a siliceous sponge attached by its expanded base to some marine body, supported by a skeleton of a cylindrical tubular form, formed of numerous elongated fibres, consisting of fascicules of very long slender linear cylindrical spicules, and crossed by similar fascicules of spicules, forming a square network which at length is covered by a finer network of fibres, producing concentric and oblique ridges across the outside of the tube, and a broad expanded fringe round the edge of the upper end of the tubular cavity of the skeleton, and covered with a network lid formed of bundles of shorter spicula.

The base of the tubular body is surrounded by a beard of elongated, free, siliceous filaments which have recurved hooks near the end, and which form a ring of recurved hooks at the top. See Pl. xi. and xii.

The tube is generally gradually tapering and bevelled on one side at the base, but some specimens are shorter and more ventricose, and more or less ovate or oblong cylindrical.

The skeleton before it is perfectly formed, merely consists of a tube formed of longitudinal hoops of transverse fibres without any lid; the lid is next developed and at length the frill round the end of the tube, and finally the oblique and cross ridges formed of the finer external network, are also developed. The score of specimens in the British Museum exhibit each of these states, proving that the absence of the lid or of the fringe or of the external ridges are not specific characters. The free filaments

forming the frill round the base of the tube are found in the youngest and least developed specimens, but they are sometimes torn away by the dealers who send over the specimens, or perhaps destroyed in preparing them for the market.

The history of the described specimens shows how gradually the real structure of a rare object becomes known.

The specimen described by MM. Quoy and Gaimard only consisted of the tube without any base or terminal fringe.

Mr. Cuming's specimen, described and figured by Professor Owen, was an adult specimen, with the dilated base, the netted lid, the fringe round the edge of the tube near the lid, the external ridges and finely netted outer coat that strengthens the tube, but it was destitute, or nearly so, of the free filaments that arise from the roots and surround the lower half of the tube like a large beard.

Dr. Farre's specimen, also described by Professor Owen, has the free filaments at the base well developed and preserved, and the cavity of the sponge is covered with a well-developed lid. But this specimen is not perfectly grown; the fringe round the edge of the tube near the lid, and the outer netted coat and the transverse ridges on the outer surface of the tube are not developed.

It is probable that all these differences only depend on age and the state of the specimen. But Professor Owen regarded Mr. Cuming's specimen as distinct from those of MM. Quoy and Gaimard, because it had a fringe and netted lid; and Dr. Farre's as distinct from Mr. Cuming's, because it was destitute of the fringe round the upper part and the ridges on the outer surface of the tube.

The lightness, elegance, and rigidity of the tube, give the idea of a beautiful and complicated piece of lace work that has been suddenly petrified into a hard and transparent stone. The interlacing of the fibres of which the tube is composed has the same appearance as canework of the very different transverse and angular directions of the fibres leaving a round mesh.

Professor Owen well observes to the question put by almost every one to whom the *Euplectella* is shown, as to how the threads could have been so regularly yet intricately interwoven: "I have sometimes replied that there has been no such thing as interweaving in the case; that no thread as such was ever laid across another in the construction of the *Euplectella*; that the analogy of human textile fabrics does not apply to this beautiful natural object. In artificial network the several stages of a complex result must be taken in the succession indicated by painful and equal calculation; in organic lacework different stages are done at once; thus it is the Divine work surpasses that of man's utmost ingenuity. The threads of the *Euplectella*

HOSPITALS.*

THOUGH this work hardly comes within the scope of the Popular Science Reviewer, we venture to call attention to it because of its high intrinsic merits, and from the circumstance that many of our readers are interested in hospitals or other charitable institutions, and will, we believe, be glad to know upon what general sanitary principles, hospitals and such like public buildings should be cultivated. All the information which can be desired on these points is to be found in the fine volume before us. Dr. Oppert not only goes into the minutest questions of hygiene, as relating to hospitals, but he discusses the points on which he dwells with candour and earnestness, and so far as we can discern, he leaves no views unnoticed, no matter whether they be opposed to his own independently formed opinions or not. It is impossible for us to attempt even the briefest analysis of his labours, but we may state the nature of the division which he has adopted for his subject. We may say that his book is divided into three portions; in the first the principles on which hospitals should be constructed are minutely detailed, then follow an expression of opinion as to the Administration of hospitals, and finally we are given a succinct account of the hospitals of the United Kingdom and of the Continent. There is only one point which we desire to bring under our readers' notice, and that is the question of ventilation. Dr. Oppert explains fully the different forms of natural and artificial ventilation which are used in European Hospitals, and then proceeds to offer his own opinions as to the mode to be preferred. He advocates neither the strictly natural nor the artificial means, but considers that the *juste milieu* is the best. His remarks are of much importance, for what he asserts of hospitals must within certain limits be true of private dwellings. The conclusions at which Dr. Oppert arrives are thus formulated. (1.) Ventilation by doors and windows cannot at any time be dispensed with in hospitals. (2.) Hospitals may rely on ventilation by windows and doors in summer time, but if an artificial system is to be instituted, none but that by forcing in the air is efficient in summer. (3.) In winter time some of the artificial systems may operate with advantage, and cannot be dispensed with in clinical wards or consumption or fever hospitals during the cold season. (4.) No channels for withdrawing air should be formed, unless a continuous draught is caused in them. A ventilating fire is a more powerful agent than a hot cistern, and for the lower floors it is better to have the fire in the basement. If there is a second or third the fire should be as near them as possible, and not in the basement. (5.) Where hot-water pipes or stoves are used for warming, the outer air may pass over or through them into the wards by channels communicating with the atmosphere; where there are only chimneys, they may be surrounded by an air-chamber to the same purpose. Such an arrangement is indispensable with the new improved fire grates. (6.) Open chimney fires are capital aids to ventilation, and can be combined with every other system. (7.) The construction of the windows

* "Hospitals, Infirmaries, and Dispensaries: their Construction, Interior Arrangement, and Management." By F. Oppert, M.D. London: Churchill, 1867.

is most important, and should be considered well whenever a new hospital is erected. It is not necessary that they should be on a uniform plan. No large entrance door should be without a large louver above. (8.) Two zinc plates or tablets should be placed in the upper part of or above some of the windows, in order to break the air current, the inner plate sliding over the other, so that the apertures may be closed. The nurse to keep a rod for this purpose.

THE SCIENCE OF A CYCLONE.*

FROM year to year we receive abundant testimony of the activity with which Indian scientific workers carry on their researches, and the latest result in this direction which we have to record is embodied in the valuable volume which we have just received from the Bengal Government. This work is a veritable *chef d'œuvre* of scientific acumen, earnest labour, persevering energy, and skilful discrimination. It would be creditable to any country, but it is doubly creditable to a country wherein civilisation is as yet incomplete and where climatal conditions are so eminently unfavourable to intellectual pursuits. Indeed we should be glad to find so excellent and elaborate an account of any important meteorological phenomenon occurring in Great Britain. Some of our readers may remember what a dreadful catastrophe the cyclone described in this report was. The storm raised a wave which poured over the country for miles, breaking down embankments, sweeping away whole villages, and with them their inhabitants. It was one of the most remarkable natural phenomena on record. Destructive of population and property, to an almost inconceivable extent, it yet might have been anticipated had meteorology been more carefully studied. As it was it produced a loss of life which is estimated below the mark at 48,685 souls.

To investigate the phenomena which preceded, accompanied and followed this cyclone is the task which the editors of the admirable work before us have set themselves to perform and which they have so successfully achieved. It is quite astounding to see the mass of evidence which has been collected from all quarters reached by the inundating wave, the more so, as the phenomenon was unexpected and was of so terrific a character that in many instances the self-registering instruments were destroyed and the meteorologists fled in horror from buildings which threatened every moment to bury them in their ruins. Numerous maps, charts, plans, and carefully compiled schedules accompany the letter-press and give adequate support to the editors' conclusions. For these latter we must refer the reader to the book itself, but the "suggestions" which are offered, are we think of sufficient interest for quotation. These are to the effect that the cyclones in the bay are preceded by a strong damp stormy wind from south-west or west-south-west to

* Report on the Calcutta Cyclone of the 5th of October 1864, by Lieut-Col. J. E. Gastrell and Henry Blanford, A.R.S.M. Calcutta Military Orphan Press, 1866.

the south-west of their origin. It is found that the barometer ranges lower than usual on the part of the bay in which they originate. This depression takes place during a slight general fall of the barometer over the bay, such as occurs normally at intervals of a few days to a fortnight, at all seasons of the year. The formation of the cyclonic vortex appears to be preceded by a general recurvature of the southerly current around the place of low barometer. When the vortex forms the barometer falls still lower over the vortex and continues to fall while the cyclone gathers strength. The recurved south-westerly current being the chief feeder of the cyclone, and the vortex being formed more or less towards its western limit, the weather to the east and north-east of a cyclone is more stormy than that to the west and north-west of it. In and around the cyclonic vortex there is a strong indraught of the wind-currents so that their direction is spiral, not circular, but more nearly circular within ten or fifteen miles of the centre than at greater distances from it. Finally the editors say that "the cyclones do not in all cases (perhaps in any?) move forward steadily on their track, but one vortex may break up while another is forming at some distance in advance." The duration of a central calm cannot therefore (even if its diameter be known) be taken as a measure of the rate of progress of the storm (the successive vortices being considered as one storm).

It will be seen by the above suggestion-conclusions, if we may use such a term, what good work Indian meteorologists have done. Let it be an example for those who so energetically decry the Fitzroy weather signals, and decline to give us even substantial facts in their stead. Let some English meteorologists follow in the footsteps of their Indian brethren and give us on the subject of "Storm-signals" a treatise of which we may say, as we do honestly affirm of the one before us, that it is a model meteorological monograph.

POPULAR ASTRONOMY.*

PERHAPS the reader may say we are overdosed with lectures on Astronomy. There appears too, to be some truth in the remark, but though of late years the works on this branch of science have been very numerous, some of them have been works whose many technicalities and references to the higher mathematics placed them at once beyond the comprehension of the amateur. It is, however, the special feature of all Dr. Lardner's books that they address themselves to the general public, and we may observe also that while they are tolerably accurate in point of fact they are written in a language at once terse and untechnical, and which is easily intelligible to those whose mathematical knowledge is of the usual elementary character. It happens, however, that a good deal of advance has been made in the several branches of science which Dr. Lardner endeavoured to popularise

* Handbook of Astronomy, by Dionysius Lardner, D.C.L., 3rd edition. Edited by Edwin Dunkin, F.R.A.S. London: James Walton, 1867.

since the period at which his various essays were published; Mr. Walton has therefore been engaged in bringing Dr. Lardner's works up to the present condition of scientific knowledge. In one of our late numbers we called attention to a new edition of Dr. Lardner's *Natural Philosophy*, and we have now the pleasure of bringing another of Dr. Lardner's books under our readers' notice. The work before us, even in its first edition, was an excellent general treatise, and the present edition is as fully in accordance with modern discovery as its predecessor was with the science of its time. Those who are acquainted with the second edition will not find many novelties in the present work. There are some new features, however, which are of interest and importance. One of the chief points in which this differs from the second edition relates to the horizontal parallax of the sun, which in conformity with the opinions of the leading astronomers has been increased from $8''\cdot5776$ to $8''\cdot94$, an alteration which necessarily involved other important numerical corrections. Among other points referred to for the first time in this volume are notices of the discovery of thirty-three minor planets. The illustrations are of an excellent character, the woodcuts intercalated with the text, being clearly executed and simple, and the plates, especially those of the comets and nebulae, being carefully and skilfully executed. The work commends itself especially to junior students, schools and families, and deserves an extensive circulation.

Natural History Transactions of Northumberland and Durham, Vol. I. Part II. Dodsworth, Newcastle-on-Tyne.—This the second part of this well-conducted publication is full of important contributions and contains a series of illustrations which would do credit to a London publisher. All the articles deserve to be read, but there is one which is worthy of careful attention, that "On an Ancient British Burial at Ilderton, Northumberland, with notes on the Skull." In this the writers, the Rev. W. Greenwell and Dr. Embleton, give a minute account of the interesting archæological district of old Berwick, and of an ancient British skull found therein. The drawing of this latter, which accompanies the paper, is certainly a masterpiece of artistic skill. We doubt whether we have ever seen a better anatomical illustration than this. The zygomatic processes stand out with an almost stereoscopic effect. The following description of this skull shows it to have belonged to a man of about forty-five years of age, and who must have possessed (so far as we can judge) a more than average degree of intelligence. The skull is robust, well-arched and symmetrical, its supraciliary arches are very prominent, and its external angular processes well developed. The forehead slightly recedes. The occipito-parietal region is large and rounded. The mouth is rather large and well-formed, and contained a full set of fine teeth. The lower jaw has a strong square and somewhat projecting chin, the angle is not far from being a right angle, and the distance across from angle to angle is considerable. The frontal sinuses appear to join together and form a projection over the root of the nose. The temporal fossæ are wide and large. The coronal sagittal and lambdoidal sutures are partially obliterated.—The other papers in this number are full of interest.

SCIENTIFIC SUMMARY.

ASTRONOMY.

IN our summary for January, it was recorded that Professor Adams had seen reason to doubt the correctness of the period assigned by Professor Newton to the November meteor-ring. The rigid mathematical scrutiny of the nodal motion due to the actions of Venus, Jupiter, and the Earth—the planets which would be the principal perturbors of the meteoric orbit on Newton's hypothesis—has resulted in showing that 354·6 days is not the true period of the orbit. In like manner a period of 377 days—another view suggested by Newton—must be abandoned. Either theory gives to the node an annual motion of about $21''$, whereas to account for the observed change in the epoch at which the November shower occurs, a motion of $52''\cdot4$ is required.

It remained to calculate the motion of the node when a period of 33·25 years is selected—that being the only other period, besides those considered, which fairly accounts for the interval observed to separate successive recurrences of brilliant meteoric displays. This period, which gives (by Kepler's law) an elliptic orbit, having a major axis 20·7 times as great as the earth's distance from the sun, presents many difficulties. The formulæ adapted to the nearly circular planetary orbits are here inapplicable. Adams applied the method given by Gauss in his "*Determinatio Attractionis, &c.*" In this method the long ellipse is broken up into small parts, and the perturbing effects of the planets on the motion of a meteor in each part is considered, the change in the node as the meteors move over each section being separately examined. The calculation is very laborious, though Professor Adams simplified the work to some extent by introducing several ingenious modifications. He found that during a period of 33·25 years the longitude of the node is increased $20'$ by the action of Jupiter, nearly $7'$ by the action of Saturn, and about $1'$ by that of Uranus. The other planets produce no appreciable perturbations. Thus the observed increase of longitude is about $28'$ in 33·25 years, or $50''\cdot2$ in one year. We have already stated that the observed motion of the node is $52''\cdot4$. The accordance is close enough to leave no doubt that the true period of the November meteors is 33·25 years.

This result very largely enhances the interest with which the phenomenon of periodic November displays must be viewed. On Newton's hypothesis one could understand the recurrence of brilliant showers during two or three successive years; since the earth was assumed to pass for two or three years in succession through parts of the ring not very far separated from each other. But with meteors travelling in an elongated ellipse, extending beyond the

orbit of Uranus, the case is far different. The part of the meteoric ring traversed at one passage has travelled away more than a 100,000,000 of miles, when the earth next crosses the stream. Therefore to understand the recurrence of star-showers during two successive years only—and we have well authenticated instances of showers occurring three or four years successively—one must conceive a stream of meteors extending more than a 100 miles in length.

This being the case it is the more remarkable to find the important November shooting-star displays, which have continued for at least 600 years, associated with a telescopic comet which has escaped discovery until quite recently. Yet it results from Adams' discovery that the orbit of the November shooting-stars accords in the most remarkable manner with the orbit of Comet I, 1866—a minute tailless comet discovered in January of that year by M. Tempel. Professor Adams' elements of the November meteors are here compared with Dr. Oppolzer's elements of Tempel's comet:—

	November Meteors.	Comet I, 1866
Period	33.25 (assumed)	33.18
Mean distance	10.3402	10.3248
Eccentricity	0.9047	0.9054
Perihelion distance	0.9855	0.9765
Inclination	16° 46'	17° 18'
Longitude of node	51° 28'	51° 26'
Distance of Perihelion from node	6° 51'	9° 2'
Direction of motion	Retrograde.	Retrograde.

This evidence following on Schiaparelli's proof of the close accordance between the orbits of the August meteors, and that of Comet II, 1862, seems all but decisive. The association of comets—and especially of comets of eccentric orbit—with shooting stars, is certainly one of the last that would have occurred even to the most speculative astronomer, yet it is now established on a foundation that will not be readily shaken.

Mr. Cleveland Abbe has discussed in an interesting paper the important question of the distribution of nebulae in space. He exhibits in a table the number of irresolvable nebulae contained in each space of the heavens extending 10 in declination and half an hour in right ascension. The result is confirmatory in some respects of that deduced by Sir John Herschel from the tabulation of a smaller number of nebulae of all classes. There is a decided paucity of nebulae in the region traversed by the Milky Way and its outliers, and an equally marked aggregation towards the poles of the Galactic circle. Mr. Abbe therefore follows Herschel in the opinion that the irresolvable nebulae are independent universes similar to the Milky Way in character, and that the magellanic clouds are members of this "system of universes," which happen to lie somewhat nearer than the others to our own universe, the Galaxy. Without pronouncing a decided opinion against these views we must point out that the method of tabulation adopted by Mr. Abbe is not very well adapted to exhibit any tendency there may exist to systematic distribution. The method described in Sir John Herschel's Cape observations seems better fitted for this purpose, and perhaps if applied to

Mr. Abbe's materials might lead to somewhat different results. The subject is one which, in the present stage of astronomical progress, deserves to be most carefully studied.

We do not hear that any views have been obtained of Mars during the recent opposition which add much to our knowledge of the features of this planet. At a late meeting of the Astronomical Society, Mr. Browning exhibited a series of views which he had obtained with Mr. Barnes' $8\frac{1}{2}$ -inch silvered glass reflector. Nearly thirty sketches were made. These agree well with those made by Mr. De la Rue with his 13-inch metal speculum, and fairly with the exquisite drawings by Mr. Dawes. We have seen no series of views, by the way, equalling the last named in fullness of detail, and in consistency.

Mr. Huggins has renewed his observations on the spectrum of Mars. Using a direct vision spectroscope, he found lines in the spectrum which he was enabled to assign to the atmosphere of Mars; since, while resembling lines produced by our own atmosphere in the solar spectrum when the sun is low—the situation of Mars precluded the possibility of their being ascribed to the earth's atmosphere. He ascribes the colour of Mars to the nature of the soil—a view confirmed by the definite outlines of regions tinted with the peculiar ochreish colour characterising Mars, and by the circumstance that the polar regions appear white, though they are seen through a greater depth of atmosphere than the equatorial regions. The views of Dr. Zöllner, quoted with favour by Mr. Huggins, do not appear quite so well worthy of confidence as those resulting from Mr. Huggins' own observations. The opinion, for instance, that the increased light near the edge of the disc is due to the existence of hills having a slope of 76° (as great as that of the Peter Botte Mountain) and distributed all over the surface of Mars, appears to us bizarre in the extreme.

Mr. Dawes appends to a valuable paper on the micrometrical measurement of double stars, a series of observations most instructive and interesting to the telescopist. Our space will not permit us to enter at length into the discussion of these, but some results are too remarkable to be passed over without comment. The effects produced by changing the figure of a telescope's aperture have been carefully studied by Mr. Dawes. A round disc placed centrally before the aperture increases the separating power of a telescope, but increases both the number and the brightness of the rings round the brighter stars. Thus the smaller components of a brighter star may be hidden by one or other of the rings. And in this connection another observation of Mr. Dawes is noteworthy; viz. that a larger aperture may fail (in appearance) to separate stars clearly divided by a smaller aperture, owing to the circumstance, that within the larger instrument, one of the rings of light round a star may happen to pass directly through the companion. A *perforated whole aperture* may frequently be employed with advantage. It has the effect of considerably diminishing the star discs owing to the loss of brilliancy, while the full effect of the whole aperture in reducing the diameter of the disc is also preserved. A triangular aperture produces an hexagonal star-disc, with bright rays from each side; these rays have an inconvenient effect, sometimes obliterating or distorting a small companion. A hexagonal aperture has the power of effectually cor-

rupting the tendency sometimes observed in telescopic star-disc to become triangular. An interesting discussion arose at a late meeting at the Astronomical Society, on this singular tendency. It has been observed by Mr. Dawes *to occur only when the wind is from the east*. The Astronomer Royal ascribed it to the effects of an easterly wind on the health, an opinion, however, in which many experienced observers do not coincide with Mr. Airy. The fact that a particular aperture corrects the tendency seems, also, decisive on this point. A kindred phenomenon, the circumstance that a shorter focus is required for objects near the horizon or seen through a haze, was discussed in connection with the other. Here again the Astronomer Royal held an opinion not accepted by several distinguished observers. He ascribed the phenomenon to the difference between direct and skew vision. We believe that Mr. Dawes never uses skew vision, his observing chair being ingeniously contrived so as to give in all cases direct (and comfortable) vision. The fact that a short focal length is required for parts of the sun near the limb, and a long focal length for the moon, seems to show that the question is merely one of distinctness of objects. In proof of which we may quote Mr. Dawes' observation, that young observers, in their anxiety to see perfectly well while setting the focus, use nearly always too short a focal length. Here our comment on Mr. Dawes' valuable paper must cease; but we commend the whole of it to the most careful study of the telescopic observer.

An error in M. Leverrier's calculation of the sun's distance from the earth's parallactic inequality has been detected by Mr. Stone. The result is to reduce the estimate by 400,000 miles, or to give the value already obtained by M. Hansen. Mr. Stone has himself obtained a new estimate. His calculation, founded on the observation of Mars, gave, as our readers are aware, $8''\cdot94$ for the sun's equatorial horizontal parallax—the same value, nearly, as had resulted from Leverrier's faulty calculation. Mr. Stone's examination of Greenwich lunar observations, bearing on the lunar parallactic inequality, gives a parallax of $8''\cdot85$. The values now being obtained by different astronomers cluster closely round M. Hansen's value $8''\cdot916$.

Mr. Stone has examined the question of the sun's motion in space, with results confirmatory of those already obtained. But he considers that the sun's motion is not so great as that of most stars.

He has also examined the interesting question of possible changes in the earth's axis of rotation, accruing from the action of the tides. He finds no evidence pointing to the possibility of appreciable change, even in long intervals of time.

The eclipse which occurred on the morning of March 6, was observed by several astronomers. One observer noticed that the penumbra of a spot on the sun appeared to grow indistinct as the moon's limb approached it, an observation suggesting the existence of a lunar atmosphere of small extent. Mr. Browning and Mr. Lassell noticed that a snow storm occurred in the upper regions of air during the progress of the eclipse. We find nothing else worthy of special record.

From India we hear that the November meteors were well seen at Kishnagur, fifty miles north of Calcutta. Places from which the shower is now known to have been seen range over a full fourth of the earth's surface.

¶ We hear, also, of a meteor shower observed on October 25, 1866, at noon in West Australia.

On August 21, Jupiter will appear for an hour and three quarters without visible satellites. The occultations, eclipses, and transits of the several satellites will doubtless be watched with interest by the telescopist.

BOTANY.

The affinities of Erica carnea.—Dr. H. F. Hance has contributed a paper on this subject to the *Journal of Botany*, in which he gives some very useful comparisons of *E. carnea* with the allied European species. The specimen examined by him had been collected in Devon, and had lain unnoticed for several years in his herbarium. It seems to be most closely related to *E. Mediterranea*; so closely, indeed, that Mr. Bentham unites the two. This view is, however, opposed by Mr. H. C. Watson, the accomplished editor of the *Cybele Britannica*, who explains what he considers an error, by supposing that Mr. Bentham must have confined his examination to herbarium specimens, "which are much alike, although in a living state the whole habit of growth of the two species as well as their climatal requirements are widely dissimilar." Nyman gives the following as the distribution of the species:—*E. carnea*: Switzerland, Austria, Germany, Italy, Dalmatia, Croatia, Hungary, Transylvania, and Greece. *E. Mediterranea*: Inland France, Spain, France, and Portugal. Dr. Hance seems to have given the matter some attention, and his conclusion is as follows:—"On comparing the Devonshire plant with the Irish one, and with a Tyrolese specimen from Mr. Baker, and a Savoy one collected by Huguenin, of *E. carnea*, it is evident that it agrees rather with the latter;—the corolla being constricted at the throat, the anthers entirely exerted—and the leaves, some of which are conspicuously keeled, whilst others are as evidently furrowed beneath—having the decurrent line from their base distinctly prolonged to the second whorl beneath them. I fear, however, that implicit reliance cannot be placed on the two last characters, which Professor Babington gives as diagnostic, for in *E. carnea* the median keel of the leaves, though apparently always distinct at the base, sometimes gradually merges into a furrow about halfway up, and the ridge also occasionally ceases at the nearest inferior verticil. Nevertheless, the shorter, wider, open-mouthed corolla, and semi-included anthers of the Irish species give the flowers so very distinct an appearance, that I do not think the two could well be confounded."—*Vide the Journal of Botany*, May.

A Hybrid Palm of a very remarkable character has been produced by M. Denis of Hyères. He obtained it by impregnating the ovules of *Chamerops humilis* with the pollen of *Phoenix dactylifera*. As might have been expected, the hybrid is intermedial in character between the two parents; but the plants produced from its seeds resemble the male plant more decidedly than the female.

The St. Mary's Botanical Lectureship.—We have much pleasure in stating that Dr. Trimen was lately unanimously elected to this office. No more

fitting candidate could have been chosen. In these pages we have frequently had to chronicle Dr. Trimen's discoveries, and we trust that his new appointment will only add vigour to his well-known spirit of botanical inquiry.

The Vascular System of the Arakaciæ, which has hitherto received hardly any attention from physiological botanists, forms the subject of a fine memoir which has been presented to the French Academy by M. Trécul, who states that its vessels are most closely allied to those of the umbellifereæ. The proper juice, or fluid, of the vessel appears to be oleo-resinous in some of the species, and gummy in others, whilst in *Panax Lessonii* this liquid is oleo-resinous in the fruit, and is gummy in the stem. The canals which contain the juice-proper are distinguished from the others by the absence of any particular membrane, and by the presence of a boundary envelope of cells, whose constituents, though not always differing in form from their neighbours, may be at once distinguished by their contents. In the roots M. Trécul has only met these canals in the bark. As in the Umbellifereæ, those of the periphery are often narrower than the others, and are situate more or less near the suberous layer, and unite with each other by oblique or horizontal branches. The details of M. Trécul's paper are too numerous for further notice. Our readers should consult the original communication for themselves.—*Vide Comptes-Rendus*, May 6th.

The Hybridization of Plants.—A paper on this interesting operation was lately presented to the Botanical Society of Edinburgh by Mr. J. Anderson-Henry. The author of the paper commenced his experiments nearly thirty years ago, being fully convinced of the accuracy of M. Lamarck's views. Among other interesting facts adduced in this paper is the following, relative to the intercrossing of the species of different countries. We give the author's own account:—"I may here notice a fact I have found of almost universal occurrence among my experiments, that when I had to cross an American with an Asiatic species, it took much more kindly than crossing either of these, especially the former, with European species; and, lest I shall not have another opportunity of recurring to this subject, I may here observe also the decided preference of plants of the southern hemisphere to intercross among themselves, however remote their original homes may be—e.g. I found how much easier it was to cross Australian and New Zealand plants with their allies of South America, than with European or kindred species in the northern hemisphere. I have also observed that true American species have greater aversion to cross with European than with Asiatic species, and that Asiatic species have no less aversion to intermix with European kinds. There is only one instance, I remember, of effecting a successful cross between an Asiatic and a European species, and that was in crossing a small species of *Rhododendron* with yellow *Helianthemum*-like flowers, being a form of *Rhododendron lepidotum* called *R. eleagnoides*, of the Sikkim ranges, with *R. ferrugineum*, a European kind. Of this cross I raised two plants; one died, and I kept the other for years; it flowered with me, the blooms being dirty red, splashed with a pale yellow tint. It was an odd-looking thing, and I afterwards sent it to Kew as a botanical curiosity."

Strength of the Stalks of Cereals not dependent on Silica.—M. Velter has

published the results of a series of analyses and experiments, which demonstrated beyond all question that the weakness of the stalks of corn—so fertile a source of injury to the farmer—is *not* due to the absence of silica. This is merely, however, a corroboration of the conclusion already arrived at by M. Isidore Pierre. But M. Velter's inquiries have been pushed further. He has found not only that a supply of silicate of potash to the growing plant renders the stem less able to resist the effects of the wind, but that the cause of weakness is a want of general nutrition, an absence of the proper quantities and proportions of all the elements which enter into the composition of the stem. His paper contains several interesting tables, and it concludes as follows:—If corn is blown down, it is not because it wants silica—which, by the way, is always present in the *free* state—but because owing to want of air or light, or want of development of the woody matter, the lower part of the stem has not undergone its proper development. The base of the stem is etiolate and incapable of supporting the ear. Giving it light, and sowing the corn in trenches, are the best means of preventing breakage.

The Corpuscles found in diseased Silk-worms.—A discussion has taken place in Paris relative to the nature of these bodies and to their mode of reproduction. MM. Pasteur and Béchamp contend that they are reproduced by *fission* and that they have seen the several stages of the phenomena. M. Balbiani, however, disputes this view and gives the following objections to M. Pasteur's observations: (1) The bodies examined by M. Pasteur may have been extraneous, and not related to the so-called *pebrine* corpuscles. (2) They may have been abnormal bodies produced by the union of two or more ordinary corpuscles which thus simulated a reproductive condition. It is not easy to see why MM. Pasteur and Béchamp should have fallen into error in this instance. At all events Mr. Balbiani's objections might be urged against even the admitted instances of *fission* in organisms.

Photographs of fossil plants.—A splendid series of photographs representative of the flora of the coal measures has been sent to the Paris Exhibition by Herr P. Goeppert, who is certainly one of our first European authorities on the subject of coal-fossils. The photographs, 29 in number, are from the typical plants of the Silesian coalfield, and are of the natural size. As the species photographed are common to England and Silesia, there is a fine opportunity for English palæontological students.

Silicified vegetable remains from Zambesi.—Some mud brought from the Zambesi by Mr. Baines has been examined by Dr. John Lowe, who boiled it in nitric acid and liquor potassæ, and found it to consist of vegetable cells perfectly silicified and mixed with numerous diatomacæ. Dr. Lowe has described the various forms met with.

The plants of Iceland.—Under this title Mr. Isaac Carroll has a paper in the *Journal of Botany* for April. He gives a long list of the plants found. He is convinced that a few weeks or months spent in the North or North-west part of the island would yield a rich harvest to the careful botanist. The most remarkable feature in the Iceland flora appears to be its strikingly Arctic character, shown by the absence of trees and the occurrence near the sea-level of plants which in Norway and Lapland are found at considerable elevations. The number of lichens is small, the lava appearing generally

to be destitute of them. Mr. Carroll found none of the larger *Parmelias*, but he states that *Cetraria Islandica* is found in great quantities on the deserts of the interior, and he thinks that a greater variety might be found if examination were made of the flat-topped basalt mountains of the North-west.

Distribution of the Diatomaceæ.—In a paper on the Protophyta of New Zealand Dr. Lauder Lindsay, after enumerating several new species of diatoms, and pointing out how much remains to be done in the departments of Desmidiaceæ and Palmellaceæ, makes some interesting remarks on the cosmopolitan character of Diatomaceæ. He doubts whether any group of plants has a wider geographical range, or whether any will be found, when thoroughly known, to exhibit a greater number of cosmopolites, a larger proportion of species which are independent of the usual restrictions of climate or latitude, elevation or depth, aqueous or terrestrial growth—or a wider range in geological time. They are to be found in every part of the world hitherto explored by man, equally within the arctic circle as under the line: they occur at great elevations on the highest mountains of the world, as well as at great depths in the ocean; in boiling or hot springs, and in the ashes ejected from active volcanoes; in running as well as stagnant, brackish or fresh as well as salt, water; on the surface of soil of various kinds; on dung and other decaying organic matters; on lichens, algae, and other plants. They abound on the antarctic ice as far south as 78°, to such an extent as to give colour to the said ice and the associated water. Not infrequently they occur also in the dust of dust-winds, and they may therefore be looked for in that of those which sweep over New Zealand from Australia. Indeed, it is difficult to say where members of this cosmopolite family will not be discovered.

Illustration of Natural Selection in Plants.—The recent continental discussions as to the origin of new animal races from monsters have led M. Naudin, the first of French botanists, to call the attention of the scientific world to some remarkable instances of the origination of species and races by variation. He states numerous examples, but we shall quote only the following. In 1861 M. Godron found in a batch of seedlings of *Datura tatula* (a plant whose fruit is covered with spines) a single specimen whose fruit was perfectly smooth. The seeds taken from this plant produced in 1862 a number of plants all of which resembled the parent. Their seeds gave rise to a third generation similar to the second, and M. Naudin has seen the fourth and fifth generation in his own museum. In all he says there are a hundred individuals not one of which shows the slightest tendency to return to the character of the typical species. They in fact constitute an entirely new race. By crossing them with the original stock, M. Godron has obtained forms which are identical with *D. stramonium* and *D. lewis*, which have hitherto been regarded as decidedly distinct species. If we add his peculiar variety of *D. tatula* and call it *D. inermis* we shall have four species produced by variation. M. Naudin thinks that the variations which give rise to new species do not require the immense number of years for their production, which is usually assigned to them, but that they occur *brusquely*, and thus, the sought for connecting links have really no existence.

Spontaneous Movement of Colocasia esculenta. M. Lecoq describes the

were not first spun and then interwoven, but were formed as interwoven, the two processes going on simultaneously, or *pari passu* ; but as in the cancellous texture of bone, the plates of bone are not first formed and then fitted to one another, as in building a house of cards, but the forming and the fitting go on together in the course of the molecular growth, I presume also that in the beautiful object which we call the *Euplectella* we have but the skeleton, and that in the living state the exquisite structure of the flinty framework may be veiled by the delicate gelatinous enveloping organic tissue.”—*Lin. Trans.* xiii. 121.

This common jelly not only developes the beautiful cornucopia-shaped vase, but if an accident occurs to it the rent is darned in a most workmanlike manner, as may be observed in a specimen which is in Mrs. Gray’s collection.

The skeleton above described, is interspersed with abundance of stellate spicules of very varying forms which are not attached to the skeleton itself, but belong to the layer of thin flesh or sarcode with which it is covered when in a living state. These spicules are of three distinct forms, and they all have acute tips to their rays; the first form is the most variable, generally varying from a simple fusiform spicule to a well made six rayed one, and sometimes these rays are divided into divergent branches. A series of these forms is figured in *Bowerb. Brit. Sponges*, t. 7, f. 174–187, and the more branched t. 8, f. 188–189, f. 5, 6. The second kind has only four rays, each of which are divided at the top into several short diverging rays like claws, figured also in *Bowerb. B. Sponges*, t. 8, f. 195, f. 8. The third kind has also only four rays but these soon divide into a number of elongated rays which converge together at the top and form a bell-shaped body, f. 7. See *Bowerb. B. Sponges*, t. 8, f. 193–194.

Somewhat similar many-rayed stellate spicules have been observed occupying a similar situation in the beautiful coral-like siliceous sponge from Barbadoes, called *Dactylocalyx Panicea*, of which there are two or three beautiful specimens in the British Museum. But the spicules of this sponge differ from all the forms observed in *Euplectella* in having the top of each of the rays furnished with a small knob like the head of a common pin; they are also figured in *Bowerbank’s B. Sponges*, t. 8, f. 190–192.

The filaments forming the fibres are very long, slender, nearly of the same diameter through their whole length, and most of them have a smooth surface. They are solid, elastic, and less brittle than one would expect from their hardness, but this arises from their peculiar composition and external structure.

This structure is common to these filaments and to all the silicious spicules of other sponges.

The elegant lightness of the flower baskets, one would think, must render them very liable to accident, but the strength and rigidity of their structure offer much more resistance than one might expect, and that this is the case is proved by the very few cases of injury that are to be found in the specimens that have been submitted to my examination. The hooks on the free filaments that form the fringe round the base of the tube and which diverge in every direction must be a great protection, as they would catch hold of and tear any sea animal that might attempt to approach it.

The thin elevated ridges which more or less completely and regularly encircle the outer surface of the tube, add very considerably to its general strength, and it is to be observed that the fringe round the apex of the tube can only be regarded as one of these transverse ribs that is more regular than the rest, and placed at the edge of the aperture of the tubular body to give strength and security to the vase.

Indeed, the more we study the structure, the more one is struck with the lightness, beauty, and admirable manner in which it is formed for the purpose of resisting injury.

When the filaments are chemically examined, they are found to consist of nearly pure silica, mixed with a quantity of animal matter that has been called kersote in other sponges. If they are placed in the flame of a spirit lamp, they become black, from the charring of the animal matter, and then split up into numerous very thin laminae, and if submitted to the action of the blow-pipe, or charcoal, they form a globule of glass. The filament is solid and hard. If the long fracture is examined with a magnifying glass, it will be found to be formed of an immense number of very thin concentric coats, placed one over the other round a centre; but the coats are best seen when the filaments are placed over the flame of a spirit lamp, when the filament splits and the coat of animal matter being burnt, the coats or layers of siliceous matter separate from each other, and are easier seen.

All the perfect specimens that I have examined, have a base consisting of a thick mass of filaments, which enclose a quantity of earth and fragments of shells, showing that the sponge grows on the mud of the sea shore. Mr. Cuming's specimen shows this structure in the state in which it is generally brought to this country, see *Linn. Trans.* xiii. t. 13, f. 1 & 3. Professor Owen calls this root "the apical extremity," and speaks of it as "the small end where they (the longitudinal fibres) begin to resolve themselves into their constituent filaments."

In the description of Dr. Farre's specimen, Professor Owen

observes: "It appears in the first described species that the fine silky filaments into which the parietal fibres were resolved at the small end of the cylindroid have been torn or detached by violence from some other body. The subject of the present description has been fortunately preserved along with the foreign body to which it was attached, by the terminal filament; such mode of attachment may now be therefore added to the generic character of *Euplectella* as above defined. Further, he calls the end of the tube next the lid the last or lowest of the transverse fibres," adding in a footnote, "on the supposition that the *Euplectella* hangs dependent from its filamentous attachment."

So that he evidently seems to think that the position in which he figured it on the plate in the *Linnean Transactions*, with the widest end of the tube (or base as he called it, downwards) is the natural position of the sponge in the sea, but he has nevertheless figured it in the reversed position, in the second figure, in the *Transactions of the Zoological Society*, that is to say, with the root-like base downwards, and the wider part of the tube above. Dr. Bowerbank thinks that "some of them are apparently of a parasitic habit," but the specimens lately received do not justify such a theory. They all seem to have lived attached to mud.

M. De Blainville, in his very useful *Manuel d'Actinologie*, described a small tubular specimen with short blunt branches like a stunted shrub, *Alcyoncellum gelatinosum*, which had been discovered and brought home by M.M. Quoy and Gaimard during their voyage, a calcareous sponge which they seem to have forgotten, for no account or figure of it occurs in their work. They quote De Blainville's character of the genus *literatim*, and apply it to their *Corbeil de Venus*, to which it has not the slightest alliance, the one being a calcareous sponge, formed of a multitude of minute three-rayed spicules, and the other, a beautiful cornucopia, formed of woven fascicules of hard, brittle, glass-like fibres, so hard that they will scratch glass.

They could never have compared the generic character which they extracted with their specimens, for the description, which is as follows, is very characteristic.

"Corps phytoïde subpierreux solidifié par des spicules *tricuspidés* à branches peu nombreuses, cylindrique fistulaire, terminé par un orifice arrondi à parois épaisses, composé de granules réguliers polygones alvéoliformes percés d'un pore à l'extérieur et à l'intérieur." *Blainv.* p. 302.

M. Milne-Edwards in his edition of Lamarck, *Animaux sans Vertèbres*, placed at the end of the sponges an account of M.M. Quoy and Gaimard's *Corbeil de Venus*, and perhaps seeing that the character that they gave in their work did not fit the

specimen he compiled a new character for the genus from the description and figure of MM. Quoy and Gaimard, paying no attention to the fact that M. De Blainville had already figured and described a very different sponge under the name of *Alcyoncellum*, so that in fact they were giving the same name to two very different sponges, a course of proceeding very puzzling to the student. Dr. Bowerbank, defiant of all the rules about priority, has chosen to retain the name of *Alcyoncellum* to the *Corbeil de Venus*, though M. De Blainville had applied it to the branched calcareous species several years previously. Professor Owen, when he described Mr. Cuming's specimen, properly applied the new name of *Euplectella*, or beautiful net, to the genus, but not because of the confusion caused by the mistake of MM. Quoy and Gaimard and M. Milne-Edwards, which would have been a very valid argument, but because he and M. Milne-Edwards misread De Blainville's name of *Alcyoncellum* for *Alcyonella*, observing that name had already been applied by Lamarck to a genus of fresh-water polypes.

Professor Owen had evidently not observed the very decided difference between the genera named *Alcyoncellum* by De Blainville and by M. Milne-Edwards, for in his paper he speaks of "*Alcyonellum gelatinosum*" of De Blainville and "*Alcyonella speciosum*" of Quoy and Gaimard as if they were the same species, instead of two sponges as unlike as it is possible for two sponges to be from each other.

All this may appear of little importance, but as the great use of Zoology is to enable the student to record his observations with accuracy, so that succeeding observers may understand them, and this can never be carried out if two very different animals or plants bear the same name, as one observer may be speaking of one animal and the other of the different one which has been called by the same name by some other describer. This has been the source of numberless errors.

The name and synonyms of the species may be tabulated as follows.

EUPLECTELLA SPECIOSA.—Gray, *Ann. and Mag. of N. H.*, 1866.

ALCYONCELLUM SPECIOSUM.—Quoy and Gaimard, *Voy. Astrolabe, Zoophytes*, 302, t. 26, f. 3, 1833, imperfect.

EUPLECTELLA ASPERGILLUM.—Owen, *Trans. Zool. Soc.*, iij. 203, t. 13, 1843, with basal filaments.

EUPLECTELLA CUCUMER.—Owen, *Trans. Linn. Soc.* xxi. 117, t. 21, a short specimen without apical fringe.

ALCYONCELLUM ORBICULA and *A. ASPERGILLUM*. — Bowerbank, *British Sponges*, vol. i. 117, t. 20, f. 356-357, p. 257.

Mr. Cuming obtained his specimen at the Island of Zebu, one of the Philippines, and all those that are now in the market are said to come from the same locality, and I believe that it is well known that they are sent from Manilla, the capital of the

Philippine Islands. They may be found in other parts of the Indian Ocean. MM. Quoy and Gaimard's specimen was presented to them by M. Merkus, the governor of the Moluccas and said to have been taken up by a sounding. Dr. Arthur Farre's specimen was presented by the king of the Seychelle Islands to Captain Etheridge, R.N. and Captain Sir Edward Belcher, R.N. brought home a very much crushed specimen obtained during his last voyage, but the habitat was not marked; indeed this specimen was picked from among the rejectamenta of the collection, and seems to have been unobserved when collected. It is to be observed that it is not decidedly stated that either MM. Quoy and Gaimard's specimen or Dr. Farre's were obtained in the localities where they were given to their respective owners, and they might have been picked up as curiosities, and sent from other quarters.

It would be interesting to discover how they have become so common all on a sudden. The Governor of the Moluccas who gave the specimen to MM. Quoy and Gaimard and the Governor of Manilla, to whom Mr. Cuming showed his specimen, each assured those gentlemen that the specimen was exceedingly rare, and the two specimens remained almost unique, one ornamenting the Paris Museum, and the other the collection of M. Cuming for some thirty years, and then they all at once became abundant and were sent to market as a regular object of trade, most of them having been specially prepared by being artificially bleached.

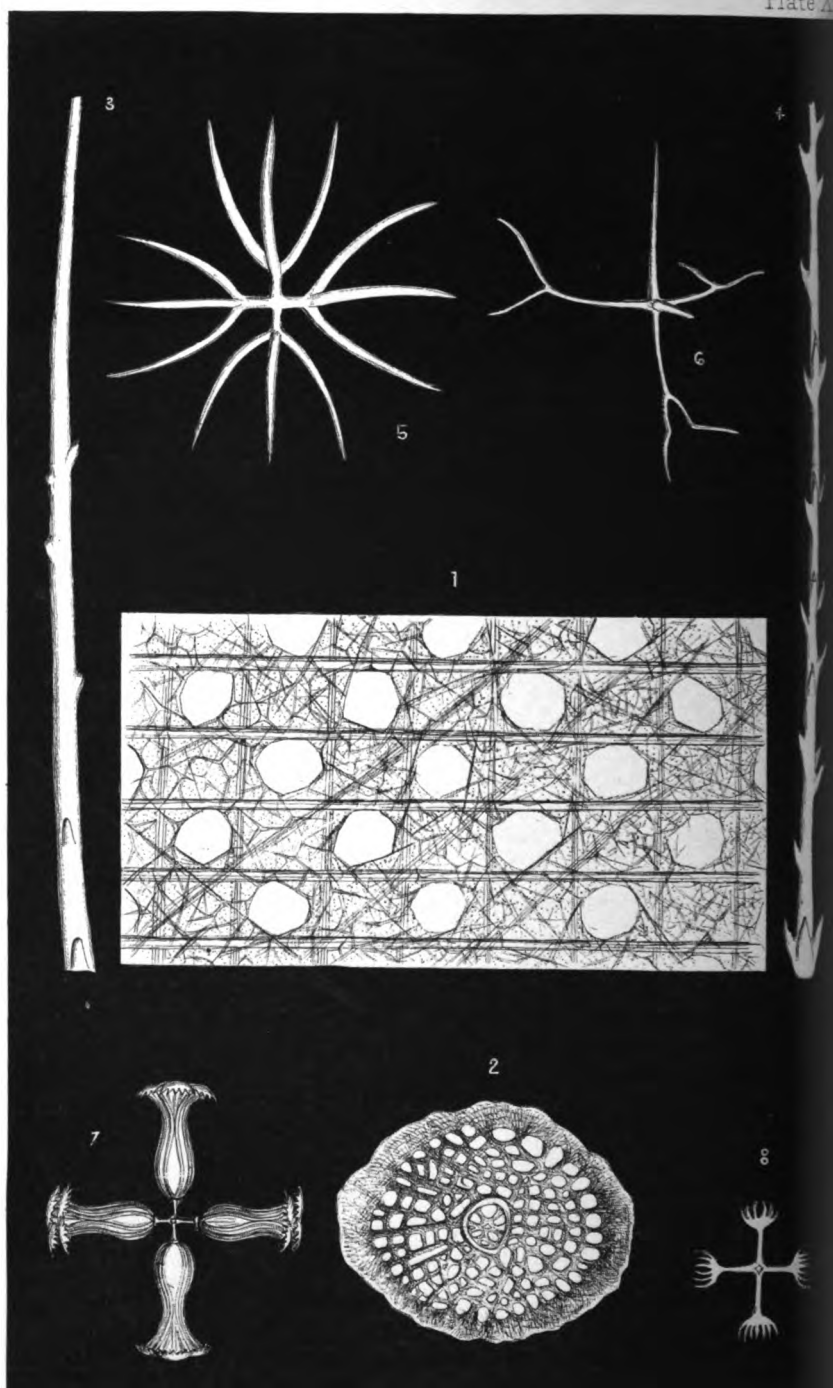
Many of the specimens have a crab in the base of the tube and it is a general belief at Manilla that the case is spun by the crab; that the male and female crab each forms a tube; and therefore they do not consider a single specimen complete without it has its fellow. This may be only as a *ruse* to induce persons to purchase a couple of specimens. The specimens with a crab in them are valued much higher than those that are without it; thus a Spaniard came from Spain with two specimens each containing a crab, and valued them at 400*l.* because they had the crabs in them. He was much disgusted when I showed him that some of those we had in the museum also had crabs, but he could only answer that in his case there were a pair, male and female. The crab might easily get into the tube before the lid is completed and it would then be caged so that it could not escape. But I am informed that the crabs are always inserted by the Manilla dealers; that they break the specimen partially across just above the root and insert the crab, and then bend the root back again. Since I have been told this I certainly have observed that all the specimens that do contain crabs are cracked near the base. At first it was believed that only one kind of crab, an Isopode, was contained

in them, and a French author has promised to write a work to prove that the flower-basket is made by the crab and is not a sponge! But I have seen several kinds of crabs in the different specimens submitted to my examination and one collector wants a large price for his specimen because he says it has twins; that is, there are two crabs in the same tube—I believe, of two kinds.

The history of the Venus's flower-basket is a good illustration, showing how completely the price of a Natural History specimen depends on the rarity rather than the beauty of the article. Mr. Cuming sold his specimen to Mr. Broderip for 30*l.* and after a time Mr. Cuming bought it back for the same price as he received for it. This specimen, which is now in the British Museum, is very much discoloured and not otherwise in a good condition. About a year ago a merchant in the city received twelve or fourteen specimens; he was informed what they were, but he declined to dispose of them until he received instructions from the person who sent them from Manilla. About four months ago he arranged with a Natural History dealer, who undertook to sell them so that he should receive 10*l.* for each specimen. The specimens were scarcely all sold at prices ranging from 10*l.* to 15*l.* each, when a few specimens came into the market, that had been sent from Manilla to Hamburg. More and more specimens arrived, and the price rapidly decreased from 7*l.* to 5*l.* and to 3*l.*, when a report was spread that 1,200, that is to say six boxes containing two hundred specimens each, had passed the custom house and were in London. The prices kept going down and it is expected that they may hereafter be sold at 10*s.* or even 5*s.* each; for a friend from Manilla informs me that they are so numerous in that town that the hawkers go about with a quantity in a basket, selling them at one quarter dollar each. However common they may become, they will always be a most beautiful object and an ornament to any room that may contain them.

The dealers like such beautiful objects to be rare and dear. On my mentioning the number that had arrived to one of them he observed, "I wish I had been present at the examination, would I not have become suddenly drunk or excited and stumbled into one or more of the boxes!" I think if he had done so he would have paid for his temerity, for the fragments of the fibres would have severely punished him and have been difficult to extract from his skin; the irritation of cowage or of the spines of the "crumb of bread sponge," would have been slight in comparison.





DESCRIPTION OF PLATES.

PLATE XI.

Venus' Flower-basket of *the natural size*.

PLATE XII.

1. Texture of the wall of the tube, *magnified*.
2. The cover of the central tube.
- 3, 4. The filaments of the basal fringe with apical and lateral hooks,
magnified.
- 5, 6, 7, 8. Stellate spicula, *highly magnified*.
From Dr. Bowerbank's "*British Spongiadae*."

JUPITER WITHOUT HIS SATELLITES.

By RICHARD A. PROCTOR, B.A., F.R.A.S.,

Author of "Saturn and its System," &c.

ON August 21, of the present year, the planet Jupiter will appear in telescopes of moderate power, to be unaccompanied for the space of one hour and three quarters by the satellites usually seen in attendance upon him. This phenomenon has been so seldom observed that considerable interest is attached to it. Molyneux on November 12, 1681 (O. S.), Sir W. Herschel on May 23, 1802, Wallis on April 15, 1826, and Dawes and Griesbach on September 27, 1843, are, I believe, the only observers who have hitherto seen Jupiter without his *comites*. It cannot be doubted, however, that if the weather be favourable, the number of observers who have seen the phenomenon, will be very largely increased before midnight August 21. It will not be wholly as a matter of curiosity that observations will be made on that night. The record of phenomena presented by Jupiter and his satellites is a regular part of "observatory work," and is very necessary for the improvement of the theory of their motions, — an important astronomical subject. A special value is attached to the record of phenomena separated by a small interval of time, so that the observations made are fairly comparable *inter se*, free from the errors arising from variations in clock rates, instrumental changes, and the like. Now on the evening of August 21 there will be *eight* phenomena visible within six hours, — viz. the disappearances, and reappearances of four satellites. To observers suitably armed there will, indeed, be no less than *thirteen* phenomena visible within the above-named interval; since the entrances and exits of the shadows of three satellites, — three phenomena in all, five will be observable with good telescopes.

Six months ago, I had occasion to treat of Mars, nearly the lowest in the scale of planetary magnitude, and interesting for presenting a charming miniature of our own earth. The contrast between this orb, and the planet we are now to consider is marked indeed. Jupiter stands at the other end of the scale of planetary magnitude. He surpasses our earth more than 1400 times in volume. Saturn alone can be compared with him.

Fig. 1

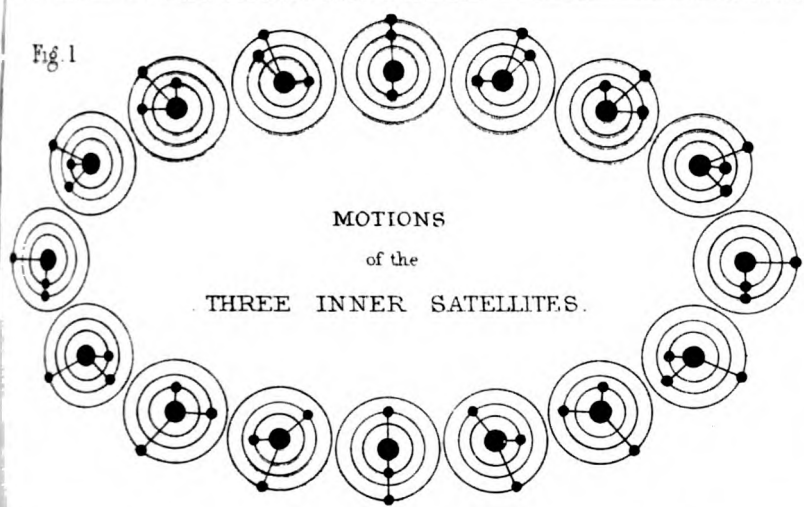
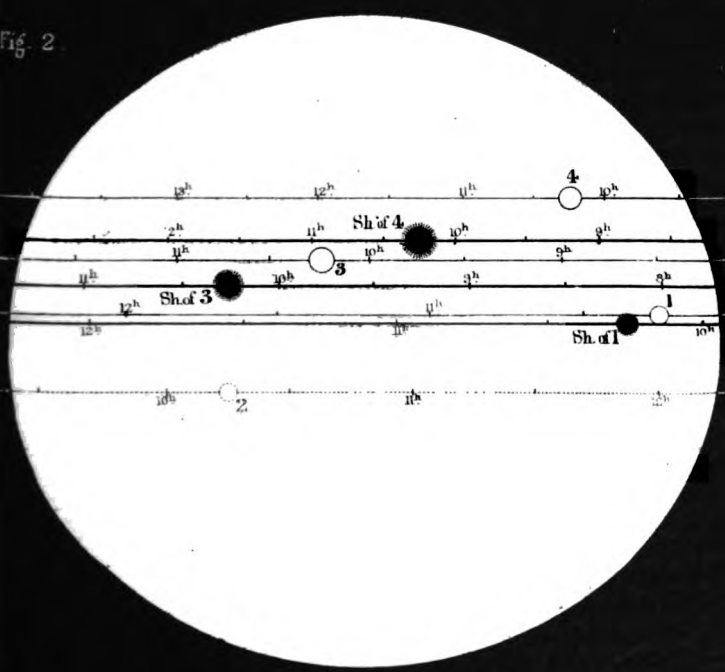


Fig. 2



in this respect, but even Saturn is but half as large as Jupiter. In mass, this superb planet is not merely "facile princeps," but exceeds much more than twofold all the other planets taken together. We may view, indeed, in Jupiter and his system, a miniature, but instead of being a miniature of our earth, it is as a miniature of the whole solar system that he is to be regarded. The sun himself, does not so greatly exceed Jupiter in volume as Jupiter does our earth. And the bodies which circle round Jupiter travel with velocities comparable with those of the swiftest members of the solar system. While Mercury and Venus travel 100,000 and 80,000 miles an hour, and our earth travels 68,000 miles an hour round the sun, Jupiter's inner satellite travels upwards of 40,000 miles an hour around its primary. Mars travels 55,000 miles an hour round the sun, the second satellite travels 32,000 miles an hour round Jupiter. Jupiter himself sweeps less swiftly round the sun than these satellites do around him, so that through a portion of their orbits they are actually retrograding. The third satellite also travels so swiftly round Jupiter, as to be reduced very nearly to absolute rest when its velocity acts in a contrary direction to that of Jupiter. The fourth satellite travels less swiftly than the third, but yet as swiftly as the planet Saturn in his orbit around the sun.

Nearly every celestial object has an interest attaching to it, other than that derived from its physical aspect,—an interest which may be called historical. In the moon, for instance, we see an object without which (it is not too much to say) astronomy would never have approached its present state of exactness and accuracy. Mars, in like manner, afforded evidence such as no other planet could supply, when Kepler was engaged in the series of researches which rendered his name illustrious, and without which Newton's views might never have been directed to gravitation as a universal principle. Venus is connected with the determination of the fundamental element of all astronomical measures,—the sun's distance from the earth. Mercury, Saturn, Uranus, and Neptune, the sun, fixed stars, comets, asteroids, and nebulae, all have their historical interest, derived from the evidence which they have afforded on special questions of interest. Jupiter is second to none in this respect. At a critical period in the history of astronomy, when the world of science was divided on the subject of the Copernican Theory of the Universe, and when all without the world of science were steadfastly opposed to the new views, the discovery that Jupiter was the centre of a miniature-system, circling around him as the theory in dispute taught that the planets circled around the sun,—came opportunely as an illustration, and to those who could grasp the significance of the phenomenon, as a proof, of the views of the

German astronomer. Later came a yet more remarkable and important discovery, through the observation of Jupiter's system,—the discovery that light does not travel as had been supposed instantaneously, but with a measurable, however inconceivable, velocity. Through this discovery, supplemented by Bradley's discovery of the aberration of the fixed stars, came a proof—which is absolutely beyond cavil or question—of the true theory of the solar system. Supplementary proofs of Newton's views have been derived, also, as might be expected, from the influence exerted by a planet whose disturbing agency so largely exceeds that of all the other members of the solar system.

Let us return to Galileo's discovery of the satellite-system of Jupiter, and the influence of that discovery on the views of astronomers. It was immediately felt, by those who opposed the new views of Copernicus, that the discovery of Jupiter's moons was fatal to their objections. Accordingly they spared no efforts in casting doubts on the observations of Galileo. Some asserted that the Tuscan had seen no such sights as he pretended. Others that he had indeed seen them, but in illusive dreams, that he was the sport of demons specially sent to punish him for a prying, inquisitive, and truth-doubting spirit. "We have looked," they said "for hours through his telescope, and have seen no such sights as he and his friends have described." When at length it was impossible to deny the existence of Jupiter's moons, it became the fashion to dispute the real character of their movements. It was argued that these objects do not revolve around the planet, but, travel backwards and forwards behind its disc. Down to the middle of the seventeenth century, many refused to believe that the satellites actually circulate around Jupiter.*

The discovery, by Cassini, in 1665, that the satellites can be traced when their orbital motions carry them between the planet and the earth, placed the true character of these bodies beyond a doubt. By means of Campani's object-glasses of 100 and 136 feet focal length, Cassini was able to see the satellites projected as small bright spots on the disc of the planet. He found also that their motions when thus situated, are precisely those due to an orbital motion around the planet, and therefore very different from those of bodies attached to the planet. This

* For aught I know the motion of the satellites may be denied to the present day. In the preface to the last edition (1823) of the *Principia*, edited by the learned Jesuits Le Sueur and Jacquier, there occurs the following remarkable passage:—"In adopting the theory of the earth's motion, to explain Newton's propositions, we assume another character than our own, for we profess obedience to the decrees of the popes against the motion of the earth." It is, therefore, not wholly impossible that decrees may have been promulgated against the circulation of Jupiter's satellites also.

circumstance, and the fact that the bright spots remain unchanged in form as they pass over the disc, proved incontestably that he had not mistaken bright spots, such as are sometimes seen on the body of the planet itself, for the satellites whose ingress on the disc he had previously watched. But he was able to detect another evidence of the true nature of these bodies, since he discovered that the shadows which they cast upon the body of the planet, are visible as small dark spots upon the disc.

Forty years later Maraldi observed that the fourth satellite does not always present the same appearance as it traverses the disc of the planet. Sometimes it appeared to him as a bright spot, at others it appeared darker than the planet. He noticed also that when the satellite seemed to be projected as a dark spot, this spot was smaller than the shadow of the satellite. "According to the laws of optics," he says, and others have followed him in the statement, "it ought to have appeared larger." Assuming this view to be correct, and that the observations of Maraldi were rightly interpreted by him, we are led to a somewhat singular result. It has been proved, (incontestably, I think) by Sir W. Herschel's observations, that all the satellites of Jupiter follow the law observed in the case of our own moon—turning constantly the same face towards their primary. He observed that each satellite varied in brightness in different parts of its orbit, but that when it arrived at the same position in its orbit, "it exhibits always the same degree of brightness." It would follow from this, that each satellite in transiting the disc of Jupiter should exhibit invariably the same appearance—since when so situated we always see the same half of the satellite, that half namely which is invisible from Jupiter. This at least, would always happen, unless a satellite were subject to transient variations of brilliancy arising from physical change occurring on its own face. Maraldi's observation would seem therefore to point to the occurrence of such changes on the fourth satellite, and corresponding observations of variations of brilliancy in the other satellites, by Cassini, Maraldi, and Pound would lead to the same conclusion as respects these bodies also. The observation by Bianchini, that in other parts of their orbits the satellites are subject to considerable variations of brilliancy, would seem to confirm this result.

Now without asserting the impossibility that the above explanation is the true one, I cannot but consider that it is highly improbable that the satellites of Jupiter are actually subject to physical changes of the kind implied. The observations of Sir W. Herschel are decidedly opposed to Bianchini's view, and scarcely less directly contradictory of Maraldi's. It appears to me far more probable that the apparent loss of brilliancy

observed by Maraldi was relative only, and due to the projection of the satellite on a brighter part of Jupiter's disc (which we know to be subject to partial variations of brilliancy) than that the whole or nearly the whole hemisphere of a satellite should suffer change in the manner imagined. The fact that the satellite appears smaller than the shadow, so far from being contrary to the laws of optics, as many have supposed, is directly deducible from those laws. The black umbra should indeed be smaller, but the complete shadow formed of umbra and pen-umbra together, should be larger than the satellite.

I may notice in passing, that observations having reference to the relative brilliancy of celestial objects are at all times difficult, but that those made towards the end of the seventeenth, and in the earlier part of the eighteenth century, appear specially unreliable. Whether from the use of unwieldy focal lengths, or from imperfection in the single object glasses, or from a want of thorough appreciation of irregularities due to atmospheric causes, certain it is that there are recorded a multitude of observations of this sort in the interval named, which have not been confirmed by subsequent observation.

Soon after his discovery of Jupiter's satellites, Galileo perceived the use to which the phenomena they presented might be applied for the determination of the longitude. He was sanguine indeed, as to the use of this method for finding the longitude at sea, not being aware, it would seem, of the mechanical difficulties which render the method unavailable on ship-board. With the object of constructing tables of the satellites' motions, he observed them for many years. The Tables he formed disappeared unaccountably on the death of his pupil Rimieri, to whom he had entrusted them for publication, and were accidentally discovered a few years ago in a private library at Rome. Notwithstanding the amount of labour bestowed upon them, the Tables are far from representing with accuracy the motions of the satellites. Galileo, indeed, and those who followed him in attempting the work of tabulating these motions, altogether underrated the difficulty of the task. A long series of observations by Hodierna, Borelli, Passini, Maraldi, Bradley, and a host of other observers, the rigid theoretical scrutiny of the subject by Newton, Walmsley, Euler, Bailly, Lagrange, Laplace, and others, and a laborious comparison of the results of observation and theory, by Lalande, Wargentin, Delambre, and Woolhouse, have been required to bring the theory of the system to the exactness and accuracy it has now attained.

The relations actually presented by the motions of the planets are very singular. They are partly exhibited by the following Table:—

Sat.	Sidereal Revolution	Same in Seconds	Sidereal Motion per Second	Distance from Jupiter's centre
	d. h. m. s.		"	miles
1	1 18 27 33.505	152853.505	8.478706	278,542
2	3 13 13 42.040	306822.040	4.223947	442,904
3	7 3 42 33.360	618153.360	2.096567	706,714
4	16 16 32 11.271	1441931.271	0.896795	1,242,619

It will be observed, at once, that the period of the second satellite is almost exactly double the period of the first, and the period of the third almost exactly double that of the second; and, of course, a corresponding relation holds amongst the sidereal motions of these bodies. This of itself is remarkable, but far more singular is the relation which regulates the extent to which the above relations differ from exactness. It is to exhibit this that I have added the column of sidereal motions, because the relation in question is masked when the sidereal periods only are given. It will be found that the sidereal motion of the first satellite, together with twice the sidereal motion of the third is *exactly* equal to three times the sidereal motion of the second satellite. Thus:—

$$(8''.478706) + 2(2''.096567) = 12''.671840 = 3(4''.223947).$$

To show the effect of this singular relation, suppose the first and third satellites to start from conjunction, then after four revolutions of the first satellite, the second has performed nearly one revolution, so that they are very nearly in conjunction again, but have in reality passed their conjunction by a small angle. At the actual moment of conjunction, the first has described three complete circumferences and an arc (A, suppose), which is nearly a complete circumference, while the third has described the arc A only; thus *twice* the motion of the third satellite added to the motion of the first gives us three complete circumferences, and three times the arc A; and therefore by the above relation the second satellite has moved through one complete circumference together with the arc A. Hence neglecting complete circumferences the actual change of position of *each* of the three satellites is the arc A, very nearly equal to a complete circumference. They therefore hold the same relative position at the end as at the beginning of the interval considered. Now nothing was said as to the position of the second satellite. As a matter of fact when the first and third satellites are in conjunction the second is always in opposition to both. Thus the actual changes of position are those exhibited in fig. 1, in which it is to be understood that the dimensions of the satellites are largely exaggerated.

Wargentin, who devoted a life to the examination of the

motions of Jupiter's satellites, but who was no adept in the higher branches of mathematics, found as the result of *observation* that the relation above described was so closely approximated to, that 1,317,900 years would have to elapse before the three satellites could be in conjunction. This result affords an interesting measure of the accuracy of observation up to Wargentin's day, since Laplace has shown that the relation is absolutely exact. Librations *may* take place on either side of the mean state (though the most careful modern observations exhibit no trace of such libration), but there is no possibility of accumulative change, save by the influence of effective agencies external to the system. It is somewhat singular that the comet of 1767 and 1779 passed through the middle of Jupiter's system, without producing any observable derangement of the mean motions of the satellites,—a fact which proves conclusively that the mass of the comet must be small, its density inconceivably minute.

In Ferguson's astronomy it is stated that the motion of the fourth satellite presents no approach to a relation of commensurability with those of the others. A simple relation exists, however, with a closeness of approximation which is quite remarkable. In fact, throughout the whole solar system there is no relation of commensurability which brings closely following conjunction-lines so near to each other as this does.* The relation is this:—three times the period of the fourth satellite is 50d. 1h. 36m. 33.813s., and seven times the period of the third is 50d. 1h. 57m. 53.520s.; the difference 21m. 19.707s. is less than one-1123rd part of the period of the fourth satellite. Thus when the third satellite has travelled round seven times from a given conjunction-line with the fourth, the fourth has gone round three times and in addition one-1123rd part of a circumference, that is less than 20', and the third overtakes the fourth before the latter has passed over 15' more (since $15 : 35 :: 3 : 7$). This conjunction-line, then is separated from a preceding one (the fourth preceding) by less than 35'. The remarkable relation which causes the "Great Inequality" of Saturn and Jupiter, brings neighbouring conjunction-lines nearly $8\frac{1}{2}^\circ$ apart, a distance fourteen times as great as the above.

From the connection between the motions of the first three satellites, it follows of course that the periods of the two inner satellites also approximate to commensurability with the period of the fourth. We have, in fact, fourteen revolutions of the second, or twenty-eight revolutions of the first, nearly equal to

* Since the above was written, I have found that some tables of elements of the Saturnian system give such periods to the satellites Dione and Enceladus as to produce a yet closer approach than that of the two satellites of Jupiter whose motions are here discussed.

three revolutions of the fourth: but the approach is not so close as in the case of the third satellite.

From the relation holding between the motions of the first three satellites it is impossible that all these bodies should be eclipsed at once; but (as will be seen by fig. 1) at regular intervals all three are in the same straight line with the planet's centre. If this happen when the sun (and therefore the earth, which with reference to Jupiter may always be considered to be close to the sun) is near the same line, these three satellites will be invisible, one or two being eclipsed, two or one (as the case may be) being projected on Jupiter's disc. Such a phenomenon is not unfrequently visible.

That the fourth satellite may be hidden at the same time it must be nearly in a line with the other three. This relation is not often presented; and, as already stated, the concurrence of this relation with the requisite configuration as respects the sun and earth, is an occurrence very seldom to be observed.

A circumstance that tends to render the simultaneous disappearance of the four satellites more uncommon than it otherwise would be, is the fact that the fourth satellite is not necessarily eclipsed or occulted at each conjunction with Jupiter. It may pass above or below his disc or shadow. In fact this happens on an average in more than one-third of the revolutions of this satellite. This is ascribed by Sir J. Herschel to the greater inclination of his orbit; but this is not the correct explanation. In fact the inclination of the fourth satellite is at present less than that of any of the others, and the mean value of its inclination is always less than that of the others. The true reason why this satellite so often escapes eclipse, is its superior distance from Jupiter.

It is commonly stated that the third satellite cannot possibly escape eclipse or occultation as it passes behind its primary, and must necessarily transit Jupiter's disc when passing before the planet. I find, however, that it is just possible for the third satellite to pass clear of Jupiter's disc in the latter case. A conjunction of many favourable circumstances is, however, required, and the phenomenon must be a very uncommon one—much more so, indeed, than that which forms the subject of the present paper. It is necessary that Jupiter should be in opposition when not far from perihelion, at which time it happens (and but for this the phenomenon could never take place) that the earth is at nearly her greatest distance north of the plane of Jupiter's orbit. The satellite's orbit must have its maximum inclination to Jupiter's orbit, and the satellite must also be at its greatest distance from the last named plane. The other satellites must also be so situated that the third is at its maximum distance from Jupiter; for it is noteworthy, that although the

orbits of the two interior satellites are described as circular, and that of the third as of small eccentricity, yet these orbits have an *ellipticity* due to the mutual attractions of the satellites. This ellipticity is wholly different from the ellipticity of the planetary orbits. The former is centric, the latter eccentric, the sun being in the focus of each planetary eclipse, while Jupiter is at the centre of the ellipse traversed by the inner satellites.

The following facts combined with the information afforded by fig. 2, will suffice to enable the telescopist satisfactorily to observe the phenomenon of August 21. The planet rises at half-past seven, almost at the same moment that the sun sets. At 7^h 44^m Greenwich mean time, the shadow of the third satellite passes on to the disc, and the satellite itself passes on to the disc at 8^h 14^m. The first phenomenon will not be observable, as the sun will not be low enough beneath the horizon nor Jupiter high enough above the horizon. Neither will the second phenomenon nor the entry of the fourth satellite's shadow on the disc, which occurs at 8^h 17^m, be easily seen. The remaining eleven phenomena will be readily seen, however. At 9^h 10^m the second satellite will disappear in the shadow of the planet. At 9^h 28^m the fourth satellite will enter on Jupiter's disc. At 9^h 57^m the shadow of the first satellite will make its appearance, followed in seven minutes by the entry of the satellite itself on Jupiter's disc. At this time (10^h 4^m) Jupiter will be without satellites in telescopes of moderate power, but large telescopes will exhibit three satellites on his disc, together with their three shadows. At 11^h 23^m, the shadow of the third satellite passes off the disc, at 11^h 49^m the satellite itself. At 12^h 13^m the second satellite reappears from behind Jupiter, at 12^h 16^m the shadow of the first satellite passes off the disc, the satellite itself seven minutes later. Lastly, at 12^h 59^m the shadow of the fourth satellite, and at 13^h 54^m the fourth satellite itself, pass off Jupiter's disc.

In fig. 2, the paths traversed by the satellites and their shadows, are indicated. The figure represents the appearance presented in an inverting telescope. It is only necessary to invert the figure to see the actual configuration. It will of course be understood that the apparent slope of the paths will vary with the hour of observation. I have made the planet's equator horizontal, instead of estimating the slope for any assigned hour; because the planet's oblateness being very observable, affords a natural feature of reference.

It will be observed that the shadows of the four satellites are very different in appearance. I have drawn them, not as they have been seen in the telescope, but as it is certain that they would appear in telescopes of adequate power. The figure and extent of the penumbrae have been determined from the simplest optical principles applied to the known distances and magnitudes of the

satellites. The figures of the shadows will suffice to afford an easy explanation of Maraldi's observation, that the shadow of the fourth satellite appears larger than the satellite.

At 10^h 15^m P.M. August 21 the positions of the satellites and shadows are those shown in fig. 2, the second satellite being, of course, behind the disc. A little examination of the figure will show that a few minutes after half-past eleven the three interior satellites are in the same line with the planet's centre.

FITZ-ROY WEATHER FORECASTS.

By G. F. CHAMBERS, F.R.A.S.

IN the present article I propose to give a general account of that system of weather forecasting commonly associated with the name of the late Admiral Fitz-Roy, discussing it historically and practically. The importance of the subject can hardly be over estimated: all classes of the community are more or less benefited by fair weather and prejudiced by foul weather, and some prior knowledge, however general, of what is to be, would rarely fail to promote our convenience in the business and pleasures of daily life.

Few sciences have been studied in a more desultory way than Meteorology, and though this remark is less true than it was a few years ago, the reproach is by no means removed. On this point Admiral Fitz-Roy felt very warmly and he seems to have been almost the first man who infused into the subject an element of practical application. In 1853 there was held at Brussels an international Maritime Congress at which Meteorology as bearing on Navigation was discussed, and in 1859 the British Association recommended to the Board of Trade the adoption of storm-signals to be circulated by aid of the electric telegraph. This recital brings us at once to the question we have in hand. Consequent on the recommendation above alluded to, Admiral Fitz-Roy was directed by the Board to prepare a scheme for conveying to certain seaports, connected with London by telegraph, intelligence of approaching storms. Nothing in the way of prediction was contemplated, only announcements of storms at some places, which storms might be expected after short intervals of time to manifest themselves at others. The conductor of the new movement was not satisfied with this moderate advance; he thought that more could be done and ought to be done and that he would endeavour to do it; in short that predictions or approximations to predictions two or three days in advance were fairly feasible. "From the very first the project was more or less opposed by many, and the old sea-wolves of the North for some time looked upon it with contempt. One day however Admiral Fitz-Roy ordered up his 'south cone' meaning that a storm was approaching from the



FITZ-ROY'S DAY SIGNALS.

Fig. 1a.

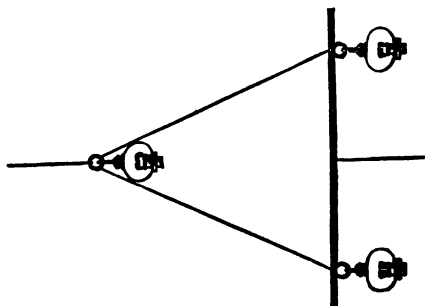


Fig. 2a.

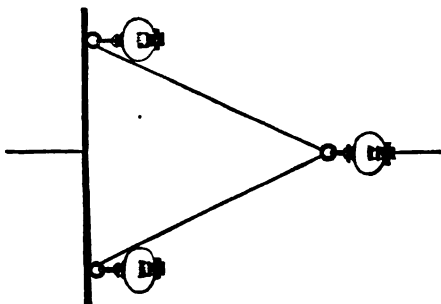
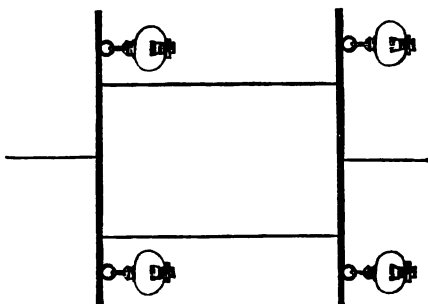


Fig. 3a.



FITZ-ROY'S NIGHT SIGNALS.

south. The good folks of Newcastle laughed at the signal. Why shouldn't they? The sky was clear and 'all serene.' *They* could see nothing to warrant the probability of a coming tempest. The fishermen put out to sea as usual. On the following morning, however, the coast was covered with wrecks, and many a family had to bewail the imprudence of the unfortunate men who had disregarded the signal. After that, people began to think that there was something in the system, and numerous subsequent fulfilments more and more confirmed the popular belief in the utility of the predictions."*

The first cautionary or storm-warning signal was issued early in 1861, being the one alluded to in the previous extract. In August of the same year the *publication* of forecasts was commenced, and after six months had elapsed for gaining experience by varied tentative arrangements, the system was launched in its final form which, so far as Admiral Fitz-Roy was concerned, remained in operation till his lamented death in 1865. The ultimate procedure was the reception by telegraph of about 18 weather reports every morning (except Sundays) from British coast-stations, besides a few from the continent. These reports gave (in cypher for the sake of brevity) the leading meteorological elements of the place of observation; such as height of the barometer, temperature, wind, rainfall in previous twenty-four hours, state of the atmosphere, sea, &c. The information thus conveyed to the London office was immediately reduced in the usual way by the application of the necessary corrections and written out in prepared forms. The first copy, with the original telegrams, was passed to the chief of the department or to the deputy appointed to act in his name, to be studied and discussed for that day's forecasts.

At about 11 A.M. expanded copies of the telegrams, together with the forecasts arrived at by the officer in charge, were sent to certain newspapers to be published in their next impressions. Copies of so much of the forecasts as related to the English Channel were also telegraphed to Paris (by special request) for the Ministry of Marine. The whole of this work was got through by about 12 o'clock. In the afternoon, from a few of the stations further telegrams were received and *when*, and so far as necessary, these were used to revise the forecasts of the morning, for the morning papers of the following day. In addition to this daily service *occasional* storm-warnings were sent to our own coasts, and to Paris and sometimes to Hamburg, Hanover and Oldenburg, by the request and *at the expense* of the public authorities in those states.

We shall presently discuss the basis on which these forecasts

* Steinmetz.

were framed and enquire into the value they were found to possess; but, before doing so, let us describe the mechanical arrangements adopted for signalling them, and illustrate by actual examples from official sources the details of the *modus operandi*, of which an outline only is presented above.

The necessary apparatus consists of a mast, of any convenient height (thirty or forty feet) two yards from four to six feet in length with the necessary ship's tackle, a cone, a drum and four signal lanterns. The cone and drum are wooden frames of those shapes covered with canvas and each about three feet high; any sort of lanterns may be used, but they must be of good size and show the same colour; what that colour be is not of great importance but *red* is to be preferred as the colour which is most conspicuous.

When hoisted, the cone appears as a dark *triangle*, and the drum as a dark square, and the import of the various signals is as follows:—

The cone with the point upwards, shows that a gale is *probable*; at first from the *northward*. This is termed for brevity "North Cone," fig. 1.

The cone with the point downwards shows that a gale is *probable*; at first from the *southward*. "South Cone," fig. 2.

The drum alone, shows that stormy winds may be expected from more than one quarter, fig 3.

The cone and drum together give warning of dangerous winds, the probable first direction being indicated by the position of the cone and its apex: cone over drum and point of cone uppermost for northerly wind (fig. 4): cone below drum and point downwards for southerly wind (fig. 5).

When these signals were, in consequence of telegrams from London, made at the several stations warned, they were kept up till the dusk of that day only, and in the official instructions issued it was stated "These cautionary signals advert to winds during some part of the next night and two or three days; therefore due *vigilance* should prevail (until the weather is again settled) without deferring *departures* or any operations *unnecessarily*."

In night signalling, only one of the two signals was used; drum *or* cone, but not both. This was for the sake of simplicity and saving of trouble.

Let us now revert to the procedure at the Central Office in London. When the system was first instituted the British Isles were divided into 6 districts, viz.:—

1. "Scotland."
2. "Ireland," around the coast.
3. "West Central" (from the Severn to the Solway).

4. "South-West England" (from the Severn to Southampton Water).

5. "South East England" (from the Isle of Wight to the Thames).

6. "East Coast" (from the Thames to the Tweed).
the coast being in each case the *points d'appui*.

These districts were subsequently consolidated into four viz. :—

1. "Northern" (Scotland).

2. "Western" (Ireland, Wales).

3. "Southern" (English Channel and Bay of Biscay).

4. "Eastern" (the East Coast of England and the North Sea.)

The telegraph being the agency for the transmission of weather news, and telegraphic messages, especially those involving figures, being costly and peculiarly liable to error, it became a matter of leading importance both to simplify and abbreviate the messages in every way possible. As a first step it was decided to discard words as far as possible, except for special purposes, and to dispense with headings, using only figures disposed in groups, the position of the figures in the several groups being, by pre-arrangement, understood to refer to certain particular meteorological elements and none others.

Thus :—

Aberdeen to London; 1862, July 25, 8 A.M.

06041 93453 94663 21072 60420 05628

This message expanded, and written out in the style familiar to every daily newspaper reader, becomes :—

1862. July 25, 8 A.M.	B	E	D	W	F	X	C	I	H	R	S
Aberdeen . .	29.39	60	6	SW	5	8	6	r	6	0.46	8

Appended to every Table thus circulated was the following "Explanation":—

B.—Barometer corrected and reduced to 32° at mean sea-level; each 10 feet of vertical rise causing about $\frac{1}{100}$ th of an inch *diminution*, and each 10 degrees above 32° causing nearly $\frac{1}{100}$ th increase. E.—Exposed thermometer in shade. D.—Difference of moistened bulb (for evaporation and dew point). W.—Wind direction (true—2 points *left* of magnetic). F.—Force. I.—Initials: *b*, blue sky; *c*, clouds (detached); *f*, fog; *h*, hail; *l*, lightning; *m*, misty (hazy); *o*, overcast (dull); *r*, rain; *s*, snow; *t*, thunder; H.—Hours of R=Rainfall, or snow or hail (melted), since last report. S.—Sea-disturbance (1 to 9), Z calm.

Eventually so much of this "Explanation" as could be so placed, was prefixed to the columns in the daily tables: hence their present form differs somewhat from the above, and they have become more convenient for perusal.

The plan upon which the meteorological information is reported to head-quarters from the several stations may be thus epitomised. Each telegram consists of five or six groups of figures (each group containing five figures) and occasionally a few words. No alterations or reductions are made by the observer who transmits them as they are read off, except in a few special cases. The reductions are performed in London with the aid of data, furnished as occasion may require, by the several observers. The first group is Rainfall (R.) omitting decimal points. With each morning report, when rain enough has fallen to be measurable, its duration in hours from 1 to 24 (or to 48 after a Sunday or holiday) occupies the first two places of a 5-figure group, a cypher being prefixed before 1 to 9: quantity of rain (snow &c. melted) is shown by the last three figures of the five as inches and hundredths. Thus if rain has prevailed for four hours since the previous report and half an inch is the gauge, the group will be 04050; if for fifteen hours with one inch and three quarters, the group will be 15175.

The second group of figures shows the highest or lowest extreme (the *most* remarkable) of the mercury in the barometer (B) and in the *exposed* thermometer (E) since the previous report by telegraph. B occupies the three first places of the group for the last integer and two first decimals; and 2 the two final figures for whole degrees of the exposed dry thermometer. Thus if the extreme reading of the barometer has been 30.129, and that of the thermometer 54.3 the group for the telegram will be 01354, the reading of the barometer being in all cases taken to the nearest hundredth and of the thermometer to the nearest whole degree.

The third group of five figures is devoted to the height of the barometer and of the attached thermometer at the regular observing hour be it 8 A.M. for a morning telegram, or 2 P.M. for an afternoon one, the method of enunciating which will be understood from the last paragraph.

The fourth group expresses the *extreme*, not simply the general character of the wind and weather (D F I) since the last report. The first two figures are allotted to the direction of the wind (D) the third and fourth to the force (F) and the last figure to the character of the weather. The direction of the wind is represented by figures 1 to 32, one for each point of the compass from N. round by E. S. and W. to N. again, North being 32, East 8, South 16, and West 24, and so proportionally for the intermediate points. A cypher preceding the points numbered below 10

(=N. by E. to E. by S.) to keep the figures in their places. The scale for force of wind (F) is 1 to 12. The character of the weather is represented by a scale of figures from 1 to 9 as follows:—

- | | |
|--------------------------|----------------------------|
| 1. Fine, clear. | 6. Gloomy, dark, overcast. |
| 2. Cloudy. | 7. Rain. |
| 3. Fog. | 8. Snow. |
| 4. Lighting. | 9. Thunder. |
| 5. Misty, hazy, obscure. | |

Thus, if we suppose the extreme direction of the wind since the last report to be S. the extreme force to be 8, and the general character of the weather gloomy and overcast, the telegraphic group will be 16086.

In the fifth group the first two figures show the reading of the exposed thermometer, (E) the third figure is difference above the damp one (wet bulb; D) and the two last figures the true direction of the wind. Thus, if the dry bulb be 58° and the wet one 52° (difference= 5°) and the wind W., the group of figures for telegraphing will be 58524.

In the sixth and last group the first two figures belong to the estimated force of the wind (F) from 1 to 12, 1 standing for a faint breeze, and 12 for a hurricane, a cypher preceding one-figure quantities; the third figure is devoted to the amount of cloud (C) from 1 to 9, 1 standing for a few clouds, and 9 for sky wholly overcast. The fourth figure gives the character of the weather according to the notation above, and the fifth figure the condition of the sea (S), also from 1 to 9. Thus, if the wind is blowing moderately, and the sky be very cloudy, the weather fine and the sea rough, the telegraph word will be 04217.

This system of reporting by telegraph the state of the weather at various widely separated stations, first set afoot by Admiral Fitz-Roy, has been maintained up to the present time, but its auxiliary, the digesting of this telegraphic news, and evolving from it some general conclusions as to the weather probably imminent, was summarily stopped by superior authority on the Admiral's death: a triumph which I trust is only temporary was given to the party, who looked upon him as a meteorological poacher, and who unceasingly sought to run him down; but all practical men who had watched with pleasure the progressively improving value of the forecasts, and especially those whose interests were most connected with the mercantile marine, learnt with great regret the decision of the (late) government, and increasing efforts have been made to procure its reversal, but hitherto (May 1867) without success. The government it must be admitted did not give the Forecast system an unqualified quietus: they appointed a committee of scientific men to enquire into the whole administration of the meteorological

logical department of the Board of Trade and to report thereon before the vacant directorship was filled up, and this committee was specially enjoined to consider the Forecasts as to their basis, and value. Their report was adverse, on the ground that sufficient data on which to found reliable predictions had not been accumulated; but this their expression of opinion was strangely at variance with the body of evidence to the contrary laid before them, and actually printed by them in their Blue Book.

They addressed through one of the permanent officials of the Board of Trade to persons occupying official positions at various seaports, collectors of customs, secretaries to marine boards, and the like, the following very peculiarly worded question. "What is the opinion of seafaring men concerning the value of the late Admiral Fitz-Roy's signals? Can you help us by telling me what is thought of them by those most competent to judge." [in your locality]?

The answers were, with one exception, highly favourable to the Fitz-Roy system. The following are some samples of them. "The utility of the signals is generally acknowledged, and for some time back the subject has obtained more attention among seafaring men. The signals for a considerable time have been very accurate." Thus wrote a competent person at Aberdeen. Dundee said "The correctness of the storm signals at this port is a matter of common remark; they are very generally appreciated." The Shipowners' Society of South Shields state that "the exhibition of the storm signals is of much practical value by giving timely warning of approaching storms." The testimony from Deal is very emphatic:—"There is but one opinion concerning the value of the signals. They have been the means of saving life and property to an immense amount." The other favourable answers were all couched in much the same terms. And in regard to the *one* hostile opinion it is worth mentioning that the writer (who hails from Plymouth) seems carefully to guard himself. He takes shelter under the very vague phrase, "*Those most likely to be informed* on the subject do not consider that the signals are in any degree of value to seafaring persons." It must I think be conceded that this expression of opinion would have been more satisfactory had some degree of particularity characterised it, had there been some statistics, some actual record of the facts (*if any*) on which it was grounded. Considering the unanimity prevailing amongst the representatives of the mercantile marine on the subject and the untiring efforts they have made to get the system again set on its legs, one is not a little puzzled to understand by what process of reasoning the committee arrived at what I venture to call their astonishing conclusion. "There is as yet no scientific basis for these daily forecasts, they are not shown to be correct in point of

fact, and there is no evidence of their utility [!!!] and we see no good reason why a government department should continue to undertake the responsibility of issuing them," or, as they elsewhere in their report express it:—"There is no evidence to show that the daily forecasts have been correct in point of fact, or that we are enabled—as Admiral Fitz-Roy declared—to know what weather will prevail during the next two or three days, and as a corollary, when a storm will occur; on the contrary, the evidence points strongly the other way."

I do not in the least desire to impugn the *bona fides* of the Committee of Investigation nor to deny that their report contains much that is interesting in itself and of suggestive practical value, still their bias against Admiral Fitz-Roy is manifest. The strongest part of their case is where they allege that one of the leading defects of the Forecast system which they found in operation at the Board of Trade was that everything was conducted too much by rule-of-thumb, or as they put it; "Many conditions and probabilities of weather are capable of being stated in the form of laws and some of them are laws which would be accepted by meteorologists generally; the probabilities are in many cases considerable, and especially in the important cases of sudden and violent changes of weather," but they "do not find that these conditions and probabilities have been reduced into any definite or intelligible form of expression, nor are they, as they now exist in the office, capable of being communicated in the shape of instructions. *Were the gentlemen now in the department to leave it, no rules would be found in the office for continuing the duties of their present basis.*" We are bound to receive this as an accurate statement, but it is not easy to reconcile these words of the committee with the fact that they have themselves presented us with a digest of twenty-four practical maxims which embody, as they imply, the leading principles upon which Fitz-Roy and his able colleague Mr. Babington actually were in the habit of preparing the forecasts of the weather. After all, then, it seems that some rules, or at least some materials for framing rules, *have* been found in the office and by the committee themselves, despite of their confident assertion that nothing existed "capable of being communicated in the shape of instructions," for I assume that they would hardly attempt to justify such a statement as this by saying that the digest of maxims which they publish had no existence until they gave it one. This cannot be their meaning, I should think.

Proceed we now to consider briefly the basis of the Forecasts. I have admitted that perhaps there was a certain amount of rule-of-thumb in what Fitz-Roy did, but inasmuch as great results were clearly achieved by him, it would be impossible not to be able to derive some benefits from the notes and memoranda he

left behind him, allowing as I freely do, that his literary style was wordy and diffuse to a most uncomfortable degree.

The following is a summary of the maxims employed in the Meteorological Office for forecasting the weather.

1. In the latitudes of the British Isles and of North Western Europe generally there are two and only two essentially different atmospheric currents of importance, one S.W. running from the equator towards the pole, and the other N.E. running from the pole towards the equator.

2. The weather in this country depends almost wholly on the conflict, combination, alternate preponderance, or alternate succession of portions of these opposite currents.

3. The characteristics of the S.W. current lie not only in its general direction but also in its quality, for it is light, warm and moist. In other words its presence is shown by a low barometer, by a high thermometer, and by a small difference between the wet and dry bulb thermometers.

4. In a similar way, the characteristics of the N.E. current lie not only in its general direction, but also in its quality, for it is heavy, cold and dry. In other words its presence is shown by a high barometer, by a low thermometer, and by a large difference between the wet and dry bulb thermometers.

5. Not only is the actual presence of either current shown by its corresponding instrumental test, but an approaching change from one current to another is foretold by the instruments beginning to change their indications. Hence as changes of weather must necessarily commence at some places earlier than at others, there is great advantage in receiving by telegraph, information of the state of the weather and of the instruments at many stations.

6. Owing to frequent conflicts of portions of the S.W. and N.E. currents followed by a temporary variation in their courses, the direction of the wind is by no means a certain test of the nature of the current of which it forms a part. A volume of air may even become wholly detached from its parent current, and be enclosed in that of its antagonist, and be drifted along with it.

7. When the S.W. and N.E. currents intermingle, water is precipitated in the form of cloud, rain or snow.

8. Most of our violent storms travel bodily in a N.E. direction.

9. The whole body of the atmosphere in our country travels in an E. direction at the rate of from two to eight miles an hour.

10. When S.W. and N.E. currents alternately prevail, the wind blowing over any station has a strong tendency to "veer" and not to back. That is to say, the general order of the changes is N., E., S., W., N., and not N., W., E., S., N.

11. The result of all rapid changes in the weather or in any

of the instrumental indicators, is brief in duration, while that of a gradual change is more lasting.

12. Rapid changes of all kinds commonly presage violent atmospheric commotion.

13. The wind usually blows from a region where the barometer is high to one where it is low.

14. The force of the wind is usually proportionate to the differences of barometric pressure at adjacent places. In other words the greater the barometric tension the stronger the wind.

15. Strong winds are far more steady in direction than light or moderate winds.

16. Great storms are usually shown by a fall in the barometer exceeding 1 inch in 24 hours, or by a fall of nearly $\frac{1}{10}$ of an inch in one hour.

17. The barometer frequently continues high during a N.E. storm, but there is a fall of the thermometer.

18. Gradual changes of weather are shown by a gradual rise or fall of the barometer; for instance by a rate of $\frac{1}{100}$ of an inch in one hour.

19. Great differences of temperature at the same or adjacent places are followed by changes of weather.

20. It is concluded from the foregoing remarks that a knowledge of the differences in the barometer and thermometer at different times in the same place are no less important than a knowledge of those simultaneously observed at different places.

21. Sea disturbance often precedes gales.

22. Great storms are frequently preceded by excessive meteorological disturbance or by heavy falls of rain or snow, by much lightning, by unusual cold, or by excessive heat.

23. Calms may be due to either of three different states of weather:—(a) The appulse of winds coming together from opposite quarters. (b) The divergence of winds going towards opposite quarters. (c) The centre of cyclonic storms. The barometer rises in (a) sinks in (b) and is extremely low in (c).

24. Beyond a doubt electricity plays an important part in the state of the weather, but at present we possess no means of stating any defined conclusions.

The forecast for each of the districts into which the United Kingdom was divided, was obtained by summarising the actual weather prevailing in the several districts and by applying to this summary the foregoing maxim. The separate forecasts were then collated and revised, regard being had to (1) the mutual actions of the estimated weather in each of the other districts. (2) To scattered information in respect to such distant areas of high and low barometer, as the limited number of continental stations afford; and (3) to geographical conditions of mountain, plain, or sea by which the free movements of the

air may be affected. "It is the custom of the department to perform the whole of the foregoing operations and to determine the forecast after a simple inspection of the list of weather returns. No notes or calculations upon paper are made. The operation lasts about half-an-hour and is conducted mentally." The committee admit that they know nothing as to how Admiral Fitz-Roy dealt with (1) but they next give in their report some elaborate calculations founded on the doctrine of probabilities by which (as they no doubt suppose, fairly) they show the value of the forecasts to be practically *nil*. I conceive it to be quite unnecessary either to reproduce or to comment on this special pleading in the face of the testimony set forth in an earlier part of this article. If further proof were necessary that the committee in doing their work were embarrassed between their prejudices on the one hand, and the hard logic of facts on the other, it is I think to be found in the circumstance, that, whilst they do recommend the discontinuance of daily forecasts, they do not recommend the abandonment of the occasional storm warnings, but seek to draw a distinction between these (which it is submitted), cannot be supported. However as a matter of fact, everything in the nature of prediction has been abandoned, and it now remains to be seen what will be the result of the pressure which it is sought to bring to bear on the Government and the new director of the Meteorological department, Mr. R. Scott. Into a general discussion as to the means we possess by notorious signs, for anticipating the weather that is to be, the space at my disposal does not permit me to enter; the subject, however, as I should wish to treat it, is essentially distinct from the purpose of this article.

ON LIFE INSURANCE AND VITAL STATISTICS.

By W. HARDWICKE, M.D.,

Deputy-Coroner for Central Middlesex, &c.

WE propose in the following pages to discuss, as briefly as possible, and without technical and mathematical references, the principles of Life Insurance, and to show, in a social point of view, the important and intimate relations of the science of Vital statistics with our commercial prosperity.

With the mass of mankind, individual efforts suffice to provide for little more than daily necessities, and it unfortunately happens, that the unexpected death of a parent, or some sudden exigency, leaves a wife and family unprovided for, or entails upon them the necessity of maintaining themselves under the pressure of adversity, or of relying upon others for their support.

The most observable feature in English character is a love of independence, and this feeling the principles of life assurance serve above all others to foster, and annihilate that sense of insecurity in individual effort, of which most persons are conscious. Life assurance is indeed a contract with certain parties who invest money by which the uncertainties of life are compensated, and by which the representatives of those who do not live the average time share in the good fortune of those who exceed it.

The words Insurance and Assurance are vaguely defined, but may with propriety be used synonymously. The word insurance is mostly used when speaking of indemnity for loss of property by fire or shipwreck; while assurance generally refers to money payment upon death, or upon other contingencies depending upon the duration of human life.

To be assured or made sure, and to be insured is much the same thing. There is, however, a distinction, which has, perhaps, a moral as well as a legal significance. Insurance against fire more nearly resembles a bargain or commercial speculation for realising a sum of money upon a chance event. Life

assurance business, on the other hand, depends upon a certainty—death—which, with the duration of life, may be brought under mathematical calculations. This view has not always been recognised; for, at one time life assurance and annuity speculations led to the enactment of laws which made penal the staking of money, by annuities or insurance, on the life of the pope, or of a king or bishop. It was believed that such transactions were attended with danger, inasmuch as those persons might be privately despatched for the pecuniary benefit that would accrue to some of those interested in their death.

Life assurance, based upon system, is, however, of modern origin. Till the beginning of this century, there were not more than half-a-dozen offices in existence. The two oldest are the Amicable (1706), and the Equitable (1762). In 1813, there were only fifteen offices; in 1825, thirty-two; whilst, at the present time, there are at least two hundred life assurance offices well-established in this country, employing no fewer than 2,000 directors and managers, with a corresponding number of clerks; moreover, agents in all our large towns are working out and rapidly extending the principles and practice of life insurance amongst the community. The wealth of some of these offices is enormous. In 1864, when the directors of seven insurance offices signed a memorial to the Chancellor of the Exchequer not to trespass upon the domain of legitimate private enterprises by introducing a government scheme, it was stated that the funds of these companies represented a capital of 100,000,000*l.*; the amount assured 300,000,000*l.*, and that new assurances were being effected at the rate of 30,000,000*l.* per annum. At the same time, it is estimated that not more than a tenth of the adult male population insure.*

Friendly societies are essentially the provident life assurance associations of the industrial ranks. They reckon above 3,000,000 members, contributing an annual revenue of 5,000,000*l.*, and possessing an accumulated capital of 20,000,000*l.*; and when the habit of life assurance becomes more general among the artisans' class, and when, as must eventually happen, the system

* Life assurance was not altogether unknown to the Romans. We have a singular record of the earliest Friendly Society in a monument discovered in Italy, where the laws of the association were inscribed on marble. It was a kind of burial club, meeting monthly. New members had to present wine, besides 1*5s.*, at entrance; 2*d.* a month was the subscription, and 2*l.* 5*s.* was allowed for funeral expenses; and the rules for preserving order and good-fellowship, and others relating to business, very much resembled those of modern friendly societies. In the middle ages, again, freemasonry, guilds, and corporations, besides promoting religion and trade, carried out the principles of mutual aid and protection, by granting pecuniary benefits to widows and orphans; and in modern times friendly societies are but a further development of life and health assurance principles.

will be recognised as the only legitimate means of repressing pauperism and avoiding the social misery which follows it, there will be an unlimited field for provident investments on life assurance principles.

The success many of these institutions have justly acquired in England, together with the confidence existing in commercial circles for this kind of security, makes this country stand pre-eminent, whilst it enables offices to establish agencies for carrying on their operations in all parts of the world. Life assurance is less successful, but gradually increasing, on the Continent. The French government endeavoured to encourage life assurance, and Napoleon ordered the Mayor and Curé of every commune to establish a *société de prévoyance et de secours mutuel*. In 1850 the National Assembly passed a law for establishing "*une caisse de retraite, ou rentes viagères pour la vieillesse*," a sort of superannuation or annuity fund for aged persons. The management of most of these associations is virtually in the hands of the government, inasmuch as the Emperor has power to nominate the president, while the number of honorary and recipient members cannot exceed 500 without the authority of the prefects or minister of the interior.

In Germany, America, and, very recently, in England, the governments have attempted to legislate in favour of Life Assurance. It would be well if *employés* in government and public offices were compelled, as in Germany, to invest a portion of their salaries in life assurance benefits for their widows and families. Perhaps, likewise, a more compulsory system, for preventing wide-spreading pauperism, may be deemed desirable in this country, when the plans, now failing, have been tried a little longer.

The science of vital statistics, upon which life assurance is founded, is one of great practical interest. It was, at one time, based upon data that were tentative; but it may now justly be considered as elevated to the rank of a science; for, by natural contingencies that admit of calculation, we may predict the average duration of life, under given conditions, almost with as much certainty as an astronomer can predict an eclipse of the sun. The mortality tables, founded on these calculations, are to the science of vital statistics what the balances, thermometers, and barometers are to investigations in physics. They serve to measure the life-force of individuals and nations, the years of life being units in the scale.

However uncertain any individual life may be, the uniformity of average is such that, where large numbers are concerned, a small fractional difference only is observed, but sufficient precision is attained for all practical purposes. Various tables have been calculated, to show the average duration of human life at

all ages: one by Dr. Price, in 1782, called the Northampton table, framed, from the ages at death of persons buried at Northampton, during forty-six years (1735-80). The Carlisle—a less accurate table—was compiled by Dr. Milne, from the mortality deduced from persons at Carlisle. More recently, a table was constructed from the ages at death of persons actually assured in several offices; this is called the “Experience table.” All of these, and one by Mr. Finlaison, calculated from 22,000 government annuitants, represent the expectation of life in persons of the higher and middle grades of society. Lastly, an English Life table was calculated, under the auspices of Dr. Farr, soon after the census of 1841, from a population of 16,000,000 persons, and the ages of death in $2\frac{1}{2}$ millions of persons. This may fairly be considered to represent, for all practical purposes, the mortality in the higher classes, professional persons, tradesmen, artisans, clerks, and servants. A further set of observations are said to be forthcoming; but they will not materially modify the character of the English Life table.

The most valuable and recent contribution to statistical science, however, is the supplementary volume of the Registrar General on the mortality of England during the last ten years, for which we are also indebted to Dr. W. Farr. This forms a most worthy complement to his former labours, in elaborating a perfect English life-table. These returns show the annual rate of mortality per 1,000, in a very extensive series of tables, from the age of five to eighty-five years and upwards, as well as the causes of death. These records enable us to observe the diversity and duration of life, in towns and country, in densely and scattered populations, amongst rich and poor, in agricultural, manufacturing, marine, and inland districts; gives us the opportunity of comparing and classifying these with each other, and of observing the differences effected by soil, climate, and occupation.

It is evident, from the perusal of this work, that there are certain districts and occupations where the mortality far exceeds the healthy standard, at ages when the majority of proposals are made for life assurance, viz. from twenty-five to forty-five. In some localities lung diseases, for instance, range from two and a half to eight times the normal average of healthy districts.

The following tables serve to illustrate:—

1.—*Differences in the mean Duration of Life.*

Ages.	English.			In Towns.	Country.	Irish.	North-ampton Table.	French.		
	Males.	Females.	Difference.					Males.	Females.	Difference.
20	Y. M. 36 6	Y. M. 37 6	Y. M. 0 11	Y. M. 41 2	Y. M. 40 4	Y. M. 34 11	Y. M. 33 5	Y. M. 38 5	Y. M. 44 0	Y. M. 5 7
30	33 2	34 3	1 0	34 10	34 2	29 8	28 3	33 2	37 7	4 5
40	26 6	27 9	1 3	27 6	27 4	23 4	23 1	27 0	31 1	4 1

Ages.	In Whitechapel.	In St. George's, Hanover Square.	Difference.
20	33 years 6 months	39 years 6 months	6 years.
50	15 „ 11 „	18 „ 8 „	3 „

2.—*Expectation of Life.*

Ages.	North-ampton Table.	Carlisle Table.	Equitable Society.	Government Annuity.	Experience of 17 Offices.	Dr. Farr's English Life Table.	French Life Tables.
25	Y. M. 30 10	Y. M. 37 10	Y. M. 38 1	Y. M. 38 4	Y. M. 37 11	Y. M. 36 8	Y. M. 37 2
30	28 3	34 4	34 4	35 5	34 5	33 2	34 1
40	23 1	27 7	27 5	29 1	27 3	26 6	27 6

The mean expectation of life term in—

London	is 37 years,	where there is one death annually in	41 persons.
Liverpool	„ 26	„ „ „ „ „ „	30 „
Surrey	„ 45	„ „ „ „ „ „	52 „

This average duration and expectation of life are the elements on which payments are calculated, to carry out a contract for assurance. An office may insure for the risk of death during one year, or for the whole future years of a person's life, as shown by the annexed English Life table. At twenty-five, the full expectation of life is thirty-seven years; and 38*l.* 1*s.* invested at three per cent. for that period will, yield 100*l.*; but a man may agree to give only 16*s.* 10*d.* for a single year's risk. This is termed "natural" premium, while it would require 1*l.* 14*s.* 11*d.* annually for the remaining years of his life if an "invariable" or "uniform" premium were paid.

English Life Table (Males), Interest at 3 per Cent.

Age.	Males living in 1000 born.	No. dying in following year.	Years Expectation of Life.	Premium for one Year's risk.	Annual Premium for the whole Life.	Premium in one Sum.	Value of an Annuity of 1 <i>l.</i>	Life Annuity which 100 <i>l.</i> will purchase.
25	321	3	37	£ s. d. 0 17 2	£ s. d. 38 1 0	£ s. d. 1 15 9	£ s. d. 21 5 5	£ s. d. 4 14 0
30	307	3	33	0 18 11	41 3 8	2 0 9	20 3 11	4 19 0
35	291	3	30	1 1 3	44 13 6	2 7 0	18 19 11	5 5 3
40	275	3	26	1 4 6	48 10 9	2 14 11	17 13 5	5 13 2

In some of the old tables higher rates were charged. Such is the practice generally adopted. The amount in this table is without the addition or loading of premiums, for the purposes of management, profits, bonuses, and other contingencies.

Some offices have a table of rates increasing every five years; others may prefer decreasing rates of premium, graduated in various manners. It matters not much, however, at what age a person commences assurance; the more advanced in life of course pay higher premiums, on the chance of dying sooner, whilst the younger lives have smaller premiums, but a greater number of them. But the advantages of insuring young are manifold; bonuses steadily increasing may often double the sum insured. In the Government Life Assurance and Annuity tables the premiums are very judiciously calculated to stop at the age of sixty, inasmuch as, after that age, ability to earn money begins to be precarious with working people, and these principally the Government scheme is intended to benefit.

The deposit plan of investing money for assurance is another system, capable of much modification. In this the interest of the money purchases a policy or an annuity, and in the event of death, or previous to death, the principal can be returned.* Numerous illustrations might be given, some for purchasing deferred annuities, others for sums payable at fixed periods, endowments, &c.; but it is beyond our present object to discuss them at length.

There are three kinds of Life Assurance offices:—1st, the "Proprietary" offices, where shareholders incur the respon-

* A deposit of 100*l.* at 25 will assure 234*l.* 10*s.* 7*d.* at death; at 30, 217*l.* 9*s.* 5*d.*; at 40, 187*l.* 10*s.* A deposit of 6*l.* 0*s.* 4*d.* at 45, and annually afterwards, will secure 100*l.* at death, and the representatives may receive back all sums paid but the first.

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A married couple, of middle age, by saving 3*d.* a day may secure 100*l.* to the survivors, or a like sum to their eldest child when it comes of age.

sibility and divide the profits, in proportion to the capital they invest. 2nd, "Mutual" offices, where the insurers guarantee each other *to the extent of their funds*, and share the profits at given periods, either in the form of a *bonus*, or by reducing the annual premium, or making addition to the sum payable at death. 3rd, "Mixed" offices, in which the assured participate largely in profits, but have proprietary capital to fall back upon. The general weight of testimony is in favour of the last system, for these offices are able to declare larger bonuses than the Mutual ones, and the cost of a guarantee fund to the assured is not large. The profits on life assurance depend much upon,—1st, economy and good management; 2nd, a careful selection of healthy lives, so that the real result exceeds the calculated average; 3rd, the prudent investment of funds at interest exceeding three per cent. But to accomplish this there are delicate problems to solve: such as—the selection of lives; the determination of what amount of stock should be kept in reserve, to meet payments at a distant date; the amount required to guarantee perfect safety; the mode of ascertaining what surplus should be equitably divided, and what proportion should be divided between share and policy holders; and the adjustment of expenses to income. All these are matters which relate to the *finance of life assurance*, demanding skill and experience in this kind of business.

Although, as we have stated, life assurances are calculated upon the average expectation of persons in the whole community, yet the selection of lives is necessary to protect the offices from fraud, and to render the class of assured lives better than the general average.

A medical examiner, acting for the interest of the company, detects the existence of diseases that tend to shorten life. The duty of these medical experts is to detect those diseases which bring about an *early emergence* from the ranks of life; for, although all must die, the great object of a company is to exclude all those who are likely to die quickly. No company could realise any profit where the real expectation of life in the assured fell much below the calculated expectation, and where many short-lived persons were permitted to enter.

In the selection of lives, Dr. Mann observes, in one of his contributions to the medical statistics of life assurance, that it is of grave importance to be familiar with the waves that rise and fall below the dead level in the ocean of life, for it is in these stormy latitudes that the path of their voyage lies.

What specially demands medical attention are facts relating to the family history, inasmuch as they, more than any other, throw most light upon the probability of latent disease likely to shorten life. Suspicious lives are those who show hereditary

tendency, or otherwise, to consumption, scrofula, gout, kidney disease, asthma, heart disease, epilepsy, dysentery, and last, though not least, intemperate habits.

The admission of consumptive and intemperate persons causes immense loss to life assurance offices. Lives which become consumptive after assurance show an average duration of seven years eleven months, whilst the average expectation should have been thirty years seven months. The following table shows the value and expectation of life in temperate and intemperate persons of certain ages:—

Age.	Expectation of Intemperate Persons.	Expectation of Temperate Persons.	Loss of Life.	Loss per cent.
20	15·6	44·2	27·6	62·4
30	13·8	36·5	22·7	62·2
40	11·5	28·8	17·3	60·7

The influence of selected lives is, however, not so great as may be imagined where large numbers are concerned. The following table shows the annual mortality per 1,000:—

Ages.	Amongst assured Lives.		Amongst the general Population.
	1st Year.	1st and after Years.	
30	6½ per 1,000	8½ per 1,000	10½ per 1,000
40	8½ "	10½ "	13½ "
50	14½ "	16½ "	17 "
60	28½ "	31 "	31½ "
70	54½ "	62½ "	67 "

Some persons consider even the present mode of selection too severe, and that the field of life assurance might be extended by more general assurance of persons having a standard average of general good health. The correlation of disease is a subject deeply interesting in a life assurance point of view. Scrofula, consumption, cancer, insanity, gout, diatetes, have well-known hereditary tendencies; and, where one of these diseases has manifested itself, another in the category will, very probably, appear in the individual, or in the offspring.

Hereditary taint cannot be lightly passed over, nor can any life be considered first-class where it has been well known to exist.

Instead of rejecting, unconditionally and without explanation, a proposer whose life has been considered doubtful, and where there is an extra risk, a practice now exists of making surcharges, that is, to diminish the expectancy of life, and charge the higher

premium—a practice which general experience appears to indicate to be both inefficient and unsatisfactory.

There are companies which undertake special assurance against accidental death, in contradistinction to natural causes; and here subtle questions have arisen, to show how difficult it is to give any law a general application. Accidental death, in medical language, signifies mortal effects, produced by a blow, a fall, poisoning, suffocation, or by violent and sudden means. But legal difficulties not unfrequently arise, in contesting the nature of death resulting from sunstroke, lightning, exposure to cold and privation after or during shipwreck.

Companies are exposed to all kinds of frauds. It may be generally supposed, that a man has an interest in preserving his own life; but experience has plentifully shown, that life assurance contracts have been deliberately entered into, with a view of securing for their family that provision which they believed themselves incapable of obtaining by the usual and legitimate mode. Numerous instances illustrate the importance of making a very exact official inquiry as to the cause of death, when it appears to have been sudden and unexpected. A coroner's inquest is usually a sufficient proof as to the cause of death; but its verdict is not binding on any company, and when good reasons have existed for suspecting fraud, facts now and then come to light that show the death to have been brought about by poisoning, either accidentally, or from suicidal motives. Interesting medico-legal questions, belonging to these cases, embrace the many forms of homicide, suicide, and insanity. The practice, therefore, of making policies *indisputable or unchangeable*, after two or three years, adds much to their mercantile value; for, where fraud, by duelling or suicide, has been meditated, the claims are early, whilst, in ordinary life policies, several years elapse.

It frequently happens that a life assurance office meets with failure. Such a misfortune, however, could never occur under a prudent management. A guarantee fund need not be large; but a provision should be made for rent, salaries, advertising, and agency, or the expenses will otherwise consume the whole of the first, and probably, much of the second year's income from premiums. In a short period, however, the management expenses ought to bear only a proportion of 2 to 5 per cent. on the premiums, leaving, therefore, a sufficient margin for profit; for, as we shall have to show, a charge, or loading, is added to the net calculated premiums of not less than 20 per cent. There are, too, circumstances that cause the disruption of a young office, or necessitate its amalgamation with a more successful rival. In the first place, mismanagement, and an extravagant expenditure, with or without an adequate guarantee fund, may do it; in the

second, an interested motive may induce directors, or shareholders, to effect an amalgamation with a rich and substantial office—a proposition in no way objectionable, when there exists the least doubt of success, or of permanent stability, to the affairs of a young company.

Fraud, and various other kinds of irregularities in life assurance offices, are to be attributed, when they do occur, to directors either being too much engrossed in their own affairs, or understanding too little of those of the company, to enable them to form an opinion upon its financial position. Hence the utility of that very useful class of men—actuaries, auditors, and accountants. A system of audit by men of great experience and sagacity is, indeed, most essential in every life assurance office. Experience also shows that legislative interference may wisely be used to protect the interests of private individuals, who are now so largely disposed to invest in our numerous mutual and co-operative associations. Auditors elected by shareholders themselves are often unsafe, their investigations not extending sufficiently into details. In calculating risk, and the many financial investigations contingent upon life, the highest mathematical and scientific education is necessary to get at true results; and none but an experienced and trained actuary can, with a prospect of success, undertake these duties. We coincide with Dr. Farr, that a settled system of annual audit should be instituted, and such returns made to Government as shall enable sound offices to establish, without a doubt, their ability to fulfil their engagements.

Much more might be written to illustrate the connection of life assurance doctrines with co-operative industrial associations, investment of savings, freehold land and building societies, and their adaptability for the better regulation and security of friendly societies; and lastly, it may be predicted that a time may arrive, when it will be considered a national duty to enforce a tax upon the whole population, to meet the social miseries arising from improvidence, sickness, accidents, sudden and unexpected emergency into the less favoured ranks of life; rather than submit to the inequalities and unfairness of compulsory rates on the property and industry of a few. The poor rates are a burden upon the industrial energies of the middle class, and fail in their object; for, neither in theory nor in practice will they keep large numbers of people from destitution, even in this rich country. Men should legally endow themselves; for, just as security is the foundation of civilisation in a state, the adoption of measures by individuals to mitigate the effects of prospective misfortune, is the best foundation of social prosperity.

Fig. 1

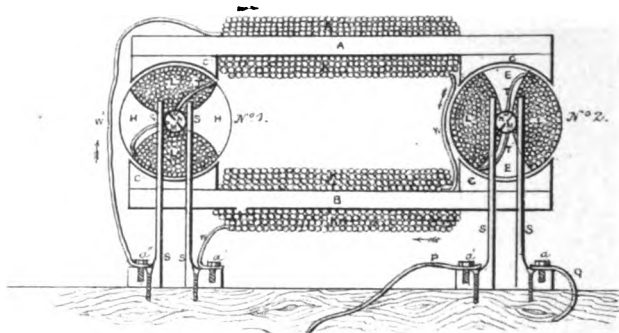
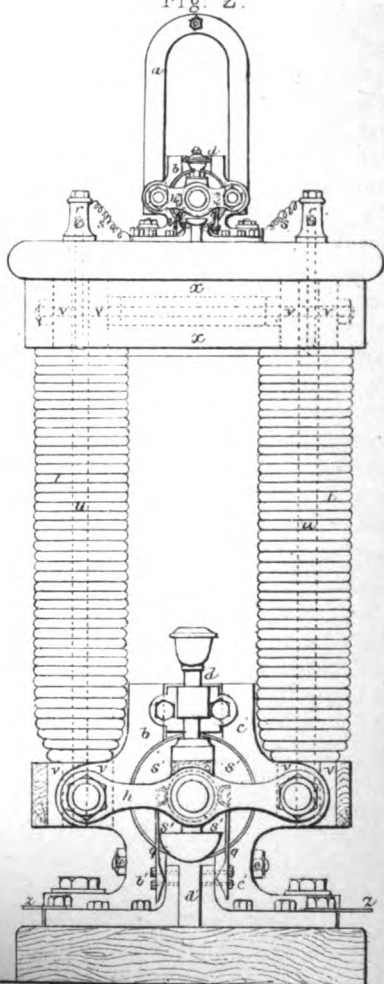


Fig. 2.



THE NEW ELECTRO-MAGNETIC MACHINES.

By S. J. MACKIE.

THE able disquisition upon the conversion of motive force into electro-magnetism made by Mr. Wilde in his paper last year before the Royal Society, gave an additional impetus to other electricians to make advances in the same direction, and both Mr. C. W. Siemens and Professor Wheatstone have since described original views and exhibited models of machines constructed upon their respective principles. Mr. Ladd, too, the eminent philosophical instrument maker, of Beak Street, also produced before the Royal Society, in a practical model, a long-conceived idea of his assistant, Mr. Tisley, a few evenings after the exhibition, at the president's soiree, of the magnificent 10-inch machine of Mr. Wilde's. Mr. Ladd has now a larger machine of two-horse power at the Paris Exhibition; and at the recent soiree of the Civil Engineers there was at work one of Mr. Siemens' beacon apparatus for flashing lights.

Of all these plans, however, Mr. Wilde's is the only one that has been practically put to the test on the large scale. We therefore begin our review with a description of that magnificent machine we have had the opportunity of seeing develop such a torrent of electrical force. Whether this force be utilised in its intensity as light, or its quantity used as a heating power, what Mr. Wilde has shown causes the strongest convictions to arise in the mind that electricity generated by engine power will be amongst the practical operations of future industry, and will take a rank no one has hitherto conceived.

We are all of us familiar with the electric light as supplied by the currents from various kinds of voltaic batteries in which chemical action gives rise to a continuous flow of electrical force. All of us, too, are familiar with the conversion of magnetism through its intensification in the induction-coil into luminous electric sparks. And, finally, very few indeed there must be who did not see Mr. Holmes' magneto-electric light in the Great International Exhibition of 1862, in which the currents were gained from numerous keepers set on the periphery of a large wheel passing between the poles of a corresponding circle of

fixed magnets. This fine light had before then sent its piercing rays for a considerable period across the English Channel, and its bright beams, projected from the lighthouse of Dungeness, had been the admiration of so many gazers on the shores of France. Mr. Holmes' revolving wheel was a somewhat cumbersome way of getting the electric power, and some important modifications of this means have been made in France.

After some years Mr. Wilde struck out a plan more powerful and less liable to derangement, and which, though ponderous as a machine, is far more compact than its predecessors. His principle is in one sense the reverse of Mr. Holmes'. Instead of an army of small keepers revolving against a circle of batteries of small magnets, he causes one gigantic keeper to revolve inside a huge electro-magnet—a revolving canal draining a saturated mountain—kept at the point of saturation by a separate charging battery of permanent magnets.

The action and power of Mr. Wilde's machine will be best understood by a general description of its parts and their separate and combined actions. The main and most prominent portion, that which not only does the most work but most attracts the eye by its massive dimensions, is the electro-magnet (u, x, u). This consists of two vertical plates (u, u) of rolled iron, 4 feet in length and 3 feet 3 inches wide; in thickness $1\frac{1}{2}$ inches. Each of these is coiled with 4,800 feet of insulated cable of 13 strands of copper wire 0.125 inch in diameter (t, t), the total weight of the coils being over $1\frac{1}{4}$ tons. Instead of the soft iron core being turned over in an arch, as in the common smaller horse-shoe magnets, these two flat sides are connected together at the top by an iron slab or hollow bridge (x, x), 1 foot 4 inches across. At the base of the electro-magnet and upon which its massive sides are secured, is the magnet-cylinder ($b' b', c' c'$), consisting of two large cast-iron segments ($b' b'$ and $c' c'$) magnetically separated in their entire length by intermediate mechanical connections of brass ($d' d'$), which form with them one cylindrical case in the bore of which the enormous Siemens' armature ($s' s' s' s'$), 10 inches in diameter, is made to revolve. Upon the top of this powerful electro-magnet is stationed a battery (a) of 20 permanent magnets, each of which is capable of sustaining a weight of 20 lbs. The magnet-cylinder for this adjunct is formed in the like manner of two segments of cast-iron (b) mechanically joined by blocks of brass (d, d), which metal not being a magnetic conductor effectually insulates the two iron segments, whilst it combines those two separate parts into one entire piece of machinery. The armature (g) which revolves within this magnet-cylinder is $3\frac{1}{2}$ inches in diameter, and is wound round longitudinally about an iron core by 80 feet of covered copper wire. Such is the machine. Now the object of its action is to

change common dynamic or motive power into electricity. To this end a steam-engine of 15-horse power is employed to drive, by means of leather bands, the armatures of the magneto-electric (α) and electro-magnetic (x, d) portions. The armature (g) is the first or magneto-electric machine (α); is driven at the rate of 2,000 revolutions per minute; and as both portions of the armature are thus presented to the poles of the magnetic battery during each revolution, 4,000 waves of electricity are transmitted per minute to the steel studs of the great electro-magnet (x, u, u) exciting it to intense action and keeping it constantly highly charged with magnetic influence. Whilst so excited its huge armature revolves with the rapidity of 1,500 revolutions per minute, thus supplying 3,000 waves of electrical force for any required practical purpose, such as the maintenance of a powerful light, or the heating of metal bars or wire, or the exercise of magnetic attraction, this great electro-magnet being capable under the last condition of sustaining a weight of 50 tons. The armatures used in this electro-magnetic portion measure 52 inches in length and are of two kinds, one for intensity, used in the production of light, the other for quantity, used for the production of heat. The intensity-armature is wound round with 376 feet of insulated cable of 13 strands of covered wire the same as that wound round the electro-magnet itself; the quantity-armature has an insulated conductor composed of 4 plates of copper, each 67 feet in length, 6 inches wide, and $\frac{1}{16}$ th of an inch in thickness, superposed in metallic contact. The weight of the armature-intensity coils is 232 lbs.; that of the insulated plates in the quantity-armature 344 lbs., and its total weight more than a quarter of a ton. The principle developed by Mr. Wilde is that by charging the large electro-magnet by means of the magneto-electric battery with as nearly as possible the quantity of magnetism it is capable of imbibing, and by means of this adjunct maintaining constantly this full charge, the maximum electrical current can be drawn off by the Siemens' armature ($s' s'$) from the electro-magnet (x, u, u). The increase of power so obtained is continuously as far greater than that which is obtainable from revolving the same armature in an uncharged or partially charged magnet as the cube of the saturation is to the cube of the residual magnetism naturally contained in the iron of the magnet.

The experiments performed with Mr. Wilde's large machine, during the time it was stationed in the lower library of the Royal Society, were most interesting and marvellous, although necessarily they were restricted in variety by the absence of auxiliary philosophical apparatus of anything like sufficient size or capacity for receiving such an unrivalled stream of electrical force, and consequently the chief display of its powers consisted

in developing its powerful light, and in the heating and fusing of bars and wires of various lengths of different metals. This light as shown in the library presented most remarkable features, and was strong enough to make itself powerfully supreme over the brightest daylight of that period of the year—February. It was generated from stout carbon points over a foot in length, and half an inch square; and when concentrated by a polished reflector, a beam of white light, 2 feet in diameter, issued forth glittering upon every object in its gradually widening path with more than the brilliancy of sunshine. Around the white central beam was an outer cylinder of bluish light, within the region of which, blue, violet, and mauve coloured ribbons and dresses exhibited the like exquisite intensification of hue as when under the rich rays of magnesium. Only one feature in the light was even seemingly at all objectionable, and this was a certain exceedingly rapid flicker; but scarcely noticeable when the back was turned upon the source. This flicker is, however, peculiar only to this particular machine, and is not observable in the smaller 7-inch or 5-inch machines which have been made by Mr. Wilde; it could be overcome in the present one by an acceleration of the speed of the armature from 1,500 to 2,000 revolutions per minute, or by the use of a commutator to send the electrical currents in one direction. In no way is it a defect, for when the light is diffused out of doors, this tremulousness is not perceptible at a short distance away; as for example, when it was displayed from the top of Burlington House, the flicker was not noticeable at the gateway of the court-yard, where at night I distinctly read the small brier print of one of the popular sixpenny editions of Cooper's "Water-Witch," and obtained distinctly the shadow of the flame of a lucifer-match on the back of my invitation card. The reason for not using a commutator, is that something of the force of the current would be lost; opposite currents are therefore allowed to alternate at the carbon points with immense rapidity, and what we really see in the flicker of the light is the flash, first of a current downward from above, and then the flash upwards of a current from below. These reversals, accomplished 3,000 times a minute, are appreciable by the optic nerves, but at 4,000 times would not be so. It is, however, no defect, as we have said, in the penetration, volume, or practical value of the marvellous beam. It was also wonderful to see the actual flames dashing out around the incandescent points of the carbons. The spectrum of the arc of light between the carbons (which were kept by a Dubosq lamp within less than a quarter of an inch of each other), as seen through a Browning's direct vision spectroscope, was most gorgeous, the lines of burning iron, sodium, and other impurities in the carbons coming out with the

greatest brilliancy, as also did a splendid bluish line far in the violet portion, and probably due to the incandescence of the nitrogen of the air.

When the carbons were placed horizontally between the actual terminals of the machine, without any reflector whatever, the light was diffused all over the room with the most agreeable softness, notwithstanding its intensity, and a modification of some such natural method would appear to be an excellent one for illuminating large squares and other public open spaces. Even in broad daylight Mr. Wilde's electric light had the power of throwing the distinct and beautiful shadow of a burning wax candle on a screen upon the wall 50 feet distant, marking out with exquisite perfection the gaseous core of the flame, bordered by a bright outline of the section of the flame itself, whilst the small inner flame, at the extreme point of the wick, was also shown in darker shadow, outlined with a fainter line of light. It cast the shadow of the flame of burning magnesium as black as night upon a wall eight feet distant, an evidence unmistakeable of the superior intensity of the electric beam, for supposing the shadow to have been that of dense fumes within the flame, it must not be forgotten that one side of the magnesium fire was still throwing all its powerful rays upon the screen over its own shadow, produced by the more distant electric light.

The heating power of the machine was shown by the fusion of a bar of iron, 15 inches in length, and more than a quarter of an inch thick; whilst upwards of 7 feet of ordinary iron wire, such as is used for the fencing of fields, was brought to whiteness, and along its entire length tears of molten metal trickled fast and freely down, until the attenuated wire broke, and fell upon the floor.

The most marvellous exhibition, however, was the actual fusion of a bar of platinum, 18 inches in length, and 0.21 inch in diameter. The high temperature at which platinum can only be melted is very well known. Indeed, it is by the oxy-hydrogen blast alone that platinum can be commercially prepared. A bar of platinum, 0.30 in diameter, was afterwards fixed to the terminals, 9 inches apart, and maintained for a short period at incandescent whiteness, but fusion was not allowed to take place, the platinum being rather too expensive a material to play freely with. The bar thus experimented upon was in value about £25.

Of the effect of the current from Mr. Wilde's machine when sent through an induction-coil, some indication was given in the effects produced upon a large instrument which had been prepared by Mr. Ladd for a smaller electro-magnetic machine. This coil consisted of four miles of No. 27 copper wire,

0·017 inch diameter, the usual wire for ordinary large coils being No. 35, diameter 0·008 inch. The current from the intensity-armature of Mr. Wilde's machine was sent through the primary wire, the induction current being then shown across the points without any condenser being used. The current was sent from the big armature for a few seconds only, Mr. Ladd being naturally afraid of damage to his instrument. The result was a perfect arc of flame which, if measured in its full high bend, would be at least 4 inches, the carbon points attached to the terminals being 2 inches asunder. When a platinum break was used with this coil for but an instant, the combustion was so great that with about a dozen flashes it so fused the ends of the platinum rods as to make the distilled water in which they were immersed like ink with the solution of the metal.

Mr. Wilde's magnificent machine is a practically accomplished fact, and we are glad to know that a 7-inch apparatus is about to be set to work for the Commissioners of Northern Light-houses.

We have next to consider the several other important models and propositions. The first of these is the proposal by Mr. Siemens to take the electrical force direct from the electro-magnet without any previous separate charging by a distinct magneto-electric machine. Mr. Siemens has found that after imparting the slightest magnetism to an electro-magnet—and there is always sufficient residual magnetism for the purpose—the armature can be made to intensify it and to impart at each revolution a higher charge to the magnet, thus absorbing at each turn more and more magnetism and returning a more and more intensified current into the magnet, causing in this way, by its own action, an incessant augmentation of force until the power of the magnet would become sufficient to arrest the action of the machine by overpowering the force employed to drive it, or by heating the coil around it to a degree that would injure the insulating cover of the wire.

Mr. Siemens' machine consists of a battery of electro-magnets, within which a coiled armature is rapidly rotated in the same way as within Mr. Wilde's large electro-magnet, the difference in the two machines being that Mr. Siemens' periodically and alternately charges and discharges the accumulated magnetism, whilst Mr. Wilde continuously withdraws the full electric force from his electro-magnet and as constantly refurnishes the electro-magnet with electricity by a separate magnetic machine acting independently but simultaneously. Mr. Siemens proposes to utilise his invention by conveying the current from the machine ashore by a submarine cable to beacons and light-vessels afloat, on board which it will be accumulated and intensified in a suitable induction-coil. A keeper attached to one end of a

lever is balanced at the other end by a heavy weight. When the induction-coil is fully charged, its magnetic attraction will draw down the keeper, and the contact of a platinum point with a cup of mercury is broken at the opposite end of the lever, a bright flash being emitted. The accumulation of electricity again goes on in the induction-coil until the keeper end of the lever is again depressed, contact broken at the opposite weighted end, and the flash repeated; and so on continuously. By means of clock-work arrangement, and an excentric plate dipping periodically into the mercury contact, the transmission of the current from the land machine can be delayed for definite intervals, and by such periods, combined with the intermittent flashes, the beacon can be made to optically speak its name in unmistakable terms and to convey its needed warning to every mariner. The commissioners of Northern Lights and some of the authorities connected with the Southern Lights have already entertained the project.

Professor Wheatstone has also proposed a similar method for the direct conversion of dynamical into electrical force founded on the like gradual augmentation of the slightest polarity into a powerful magnet. The construction of Mr. Wheatstone's model is this. The case of the electro-magnet is a plate of soft iron 15 inches in length and half an inch in breadth bent into a horse-shoe form and coiled round by 640 feet of insulated copper ($\frac{1}{16}$ th inch) wire. Within it is a rotating Siemens armature $8\frac{1}{2}$ inches long, coiled longitudinally with 80 feet of wire like that on the electro-magnet. Professor Wheatstone shows the existence of an energetic current by heating 4 inches of platinum wire .0067 inch diameter. This heating power is obtained by making a short circuit through the wire and is temporarily of great intensity but quickly subsides; and a current can then only be maintained equal to keeping one inch of the wire at a red heat.

Mr. Ladd's first model consisted of two plates of soft iron (A, B) about $7\frac{1}{2}$ inches in length, $2\frac{1}{2}$ inches in breadth, and $\frac{1}{2}$ inch thick, placed horizontally, with a Siemens rotating armature between them at each end (EE, HH). Over each of these plates about 30 yards of insulating wire (No. 10) is coiled (*kkkk*). The armature at one end (*hh*) acts in connection with a magnet or piece of soft iron, having a slight quantity of residual magnetism. The current from this armature charges the electro-magnet (*ab*). The second armature (*ee*) at the other end of the electro-magnet takes off the electricity which is conveyed by copper wires to two fixed terminals (*ss*), whence it is applied to the practical purpose required. The power of this little model is very great, and sufficient to maintain three inches of platinum wire (.01 inch diameter) at a white heat.

A valuable suggestion has been made by Mr. Tisley for coiling the armature rotating within an electro-magnet with two distinct wires so arranged that the terminals of one being in connection with the electro-magnet supplies a current to charge it whilst a current is carried off by the other wire to do the practical work required of the machine.

The machine in the Paris Exhibition has two armatures measuring 12 in. long $2\frac{1}{2}$ in. diameter; when arranged for quantity, it will give 250 cubic centimètres of mixed gases per minute. It has melted 18 in. of platinum wire 1 millimètre thick, and will maintain 4 feet 6 inches of wire 0.01 diameter persistently at white heat.

In these machines the conversion of the dynamical or driving power is direct and seemingly suffers comparatively but very little loss, and this feature is well shown in the sensitive fluctuations of the incandescence of the platinum wire between the terminals in consonance with the variations of the speed.

The final success amongst all these various and future plans will be in favour of that which will yield the most economic utilization of the primary dynamical power, and that will do this without inconvenience or delay from the swelling of the armatures, heated by the magnetic friction when rapidly rotated. The charge sent into the electro-magnet must almost be controlled within proper proportions, otherwise there will be a gain of resistance that will accumulate in the machine until it equals or overcomes the motive power. Something has been already done in this last direction by the magnetic shutter, proposed by Mr. Tisley and which being proportionately slid over the ends of the plates (*k k*) partially cuts off the magnetism acting upon the generating armature, at the same time that it gives improved effect in the armature for external work by completing the horse-shoe form of the magnet. In this way the power to work it can be regulated from two men to two horses, the total result produced of course depending upon the power primarily applied. These practical electrical subjects are already deeply occupying men's minds, and their pursuit must bring forth good fruit. In a few years, perhaps sooner, it will be our duty again to come forward to describe other new electrical machines.

THE BOTANY OF A COAL MINE.

BY WILLIAM CARRUTHERS, F.L.S.



IT is the practice to speak of the known plants of a particular geological period as a Flora, but the use of the word is apt to convey a very erroneous impression of the extent of our acquaintance with the plants that actually existed during the time that the rocks of the period were being deposited. No stranger would venture to designate the description of a hundred of our more common plants, collected during a visit of a few hours to our shores, as a "British Flora." He may have diligently employed his opportunities, and collected an unusually large number of species in the short time at his command, but at the best they would only be contributions to the greater work. One expects to find in a Flora some approach to a description of all the species found in the country.

The list of plants which constitute the Coal Flora has been considered as giving a fair representation of the vegetation of that period, but a little reflection will convince us, that from the nature of the case only a small proportion of the plants then flourishing could have withstood the numerous agencies which produced their destruction. The chief of these agencies was water. The roof shales, in which have been preserved the great proportion of the determinable remains of the plants, were mud deposits, and the water which deposited this mud must have saturated the loose vegetable matter below. Water speedily breaks up and destroys vegetable tissues, reducing them in the end to an amorphous pulp. Lindley has by experiment shown that all plants do not yield in an equal degree to this influence. He placed 177 specimens belonging to various natural orders into a vessel of fresh water. At the end of two years 121 had entirely disappeared, and of the 56 that remained, the most perfect specimens were those of Coniferæ, Palms, Ferns, and Lycopodiaceæ. It follows then, that a varied vegetation placed in the conditions under which the coal beds were formed would leave no recognisable remains, while they nevertheless might contribute greatly to the amorphous coal mass itself.

The record of the Flora of the coal measures is further

rendered defective, by the limited extent to which even those plants that are preserved in the rocks have been examined by man. And if this is true of the carboniferous period, it is much more so of all the other life systems, whose only records are to be found in the crust of the earth, for the economic value of the plant products of this period have brought under observation a larger proportion of their remains than of those of any, we may almost say, of all the other geological epochs. Yet, how little of the 100,000 tons of coal annually brought to the surface in Britain, is ever scanned by the palæontologist. It is often the merest accident that has led to the discovery of a new form, as for instance, fine and rare specimens have sometimes been disclosed by the splitting of the coal, when it was being consumed, and have been saved from destruction by the accidental glance of an educated eye. But, while the coal is brought to view, and a chance is given to examine its contents, the shales which contain the more perfect remains are left by the collier to form a secure roof to his mine.

No less than 300 species of plants have been described from the rocks of the Coal period in Britain. Many of these are, however, established on imperfect materials. The specimens are so fragmentary that it is difficult to determine the various portions that belong to the same plant. The root is rarely connected with the stem, the stem with the branches, or the branches with the leaves or fruit; consequently all these parts have been referred to different genera, and have received different names. With increased materials, and additional observations, the means are occasionally turning up, which enable us to reduce some of these genera, and while new forms are being described, the tendency of modern research is rather to decrease the number of genera and species. We shall have to adduce abundant evidence of this in the course of our paper.

Eliminating, as far as possible, the genera that have been thus erroneously founded on imperfect materials, it is remarkable to what a small number of forms the plants of the coal measures may be reduced. Ferns, and the fossils to which the generic names of *Sigillaria*, *Lepidodendron*, *Calamites*, and *Dadoxylon*, have been given, comprise almost the whole of the known Flora. Nearly half of the species described are ferns, but they do not seem to have contributed to any great extent to the formation of coal; for while their vascular tissue does not easily decompose, their remains are extremely rare in coal, and they are chiefly known from the occurrence of their fronds in the roof shales. Two or three arborescent ferns have been observed, but the great majority seem to have been herbaceous plants, which flourished on the margins of the lakes that covered the

submerged forests, or on the banks of the rivers that brought down the mud in which they are preserved.

The vascular tissues found in the coal, or seen in the film of charcoal, or so-called "mother-coal," that separates the coal into layers parallel to the surface of the seam, belong all to one or other of the genera mentioned. The absence of foliage, and of cellular plants might have been expected from the experiments of Professor Lindley, to which we have alluded. Many deposits of peat are composed almost entirely of cellular plants, and as the moist atmosphere, which necessarily prevailed in the extensive forests that covered the great areas now forming the coal fields of the Old and New Worlds, was specially fitted for the luxuriant growth of cellular parasites, such as lichens and mosses, it is probable that these simpler forms greatly helped to make up the amorphous substance of the coal. We could not expect the structure or forms of these to be preserved. The only cellular plants of the coal measures—species of polyporous fungi—have been shown by Mr. Binney to be the thick ganoid scales of a fish.

Parasites having a higher position in the vegetable kingdom than cryptogams may have flourished on the trees of the carboniferous forests—parasites analogous to the orchids and aroids of tropical forests. A confirmation of this opinion may be found in the only certain specimen of an angiospermatous phanerogam which has been found in the coal measures, and which from its resemblance to the inflorescence of some recent Aroideæ its discoverer Dr. Patterson named *Pothocites*.

In examining the principal forms of the Coal Flora we need do little more than refer to the ferns. Not only do the fossil species obviously belong to this order, but some of the forms do not apparently differ from genera now living. The fructification, when it is present, the venation, and the few specimens in which the circinnate venation has been preserved, show that in their structure and economy the palæozoic species agreed with their modern representatives. The chief difficulty that besets this study is the almost invariable absence of the fructification, upon which the modern classification of the order is chiefly based. Brongniart has employed the venation, and in the absence of fruit the best characters are to be obtained from it; but the examination of a large series of recent species shows, that many forms widely separated systematically, have similar venation. The general outline of the frond has also been used for obtaining specific characteristics, but among living forms a great variety in this respect occurs. It is probable that on account of errors from the necessarily unsatisfactory materials for classification, the number of species has been greatly overestimated,

and on the other hand that some really different plants have been united under a single species.

The plants which have contributed most largely to the formation of the coal, are those included in the genus *Sigillaria*. Their fluted trunks and tuberculated roots are among the first fossils that a student observes in a visit to a coal field. The roots (*Stigmaria*) were long a puzzle to botanists. They were observed to proceed from a large central and apparently perfect "cup or dome," and, dichotomously dividing, they extended to a great distance in the shale in which they were preserved in a singularly perfect condition. Lindley and Hutton, after examining several perfect specimens, as they supposed, during the progress of their "Fossil Flora," gave up their original opinion, that it was a prostrate land plant, and considered it in the end, as a huge aquatic plant, growing on the soft mud at the bottom of still lakes. Brongniart, from a consideration of the structures of the two genera, suggested that *Stigmaria* might be the root of *Sigillaria*; but the first step to a positive determination of the true nature of the plant was made by Sir William Logan, when he observed in the South Wales coalfield that every bed of coal rested on a layer of under clay, which was full of *Stigmaria*, and the relation suggested by Brongniart was established by Mr. Binney, who traced the connection between the sigillarian trunk and the stigmarian roots in a quarry at St. Helen's, in 1843.

The supposed leaves which are given off by the roots throughout their whole course and from every portion of their circumference, are rootlets composed entirely of cellular tissue, except a slender bundle of vessels which passes through them. These rootlets have been traced to a length of twenty feet.

Although specimens of *Sigillaria* are so abundant, they are so imperfect that less is known of this genus than of almost any of the other coal plants. It is doubtful whether the trunk was simple or branched, and whether the foliage was composed of linear leaves or fernlike fronds, and nothing whatever is known of its fructification. It is consequently not to be wondered at that very different notions have been entertained of its systematic position. By Lindley and Hutton, and by Cordau, it was referred to *Euphorbiaceæ*, by Schlotheim to palms, by von Martius to *Cacti*, by Sternberg to ferns, by Brongniart to a position intermediate between *Lycopodiaceæ* and *Cycadææ*, by Hooker to *Lycopodiaceæ*, by Dawson to *Cycadææ*, and lastly, Goeppert who has spent a long life in the study of fossil plants, writes, within the last few months, that its true position has not yet been determined.

Both Brongniart and Binney have described the internal structure of supposed species of *Sigillaria*, but the external

markings, which are the only characters by which *Sigillaria* and *Lepidodendron* can be separated, show that the fossils so described were nearer to, if not genuine species of, the latter genus. In the absence, however, of stems showing structure, several specimens of *Stigmara* have been found in which the various tissues have been preserved. In a beautiful series forming part of the collection of the late Robert Brown, I have traced the various parts. The axis was composed of elongated scalariform cells. Around this was a compact cylinder of scalariform vessels, perforated by bundles, which passed to the rootlets, but without any trace of medullary rays. This was surrounded by a considerable mass of cellular tissue, forming the great bulk of the root, through which passed the bundles to the rootlets.

The scalariform tissue and the absence of medullary rays are of importance in estimating the systematic position of the fossil, and these both clearly point to its being a true cryptogam. As the structure of *Stigmara* agrees with what is known of the stems of species described as *Sigillaria elegans*, *S. vascularis*, *Lepidodendron Harcourtii*, &c., there can be no doubt that it exhibits the true structure of *Sigillaria* itself. It is true that Dawson refers to this genus a stem composed chiefly of disc-bearing woody fibre, but it is not evident from either the drawing or description, that this remarkable stem really belonged to *Sigillaria*; and it differs so much from the known structure of the roots as well as of the allied forms named that we hesitate to place it there. The medullary rays described and figured by Brongniart have not been seen in any other specimen, and an examination of his beautiful drawings convinces me that the interspaces between the vascular tissue, which he has described as medullary rays, are accidentally produced by the splitting up of the tissues. He found no indications of the walls of the medullary cells, which would certainly have been apparent in a fossil so perfectly preserved as his *Sigillaria elegans*.

All that is certainly known of *Sigillaria*, tends to establish the opinion advanced by Hooker, that it is allied to *Lepidodendron*, and consequently belongs like that fossil, as we shall presently see, to the order *Lycopodiaceae*.

The extent of our acquaintance with *Lepidodendron* is in singular contrast with what we know of *Sigillaria*. The only part of the plant about which there is the least uncertainty is the root. The stem, branches, foliage and fruit are all well known.

Lepidodendron was a branching tree of considerable size. It is distinguished from the other genera of coal plants by the lozenge-shaped leaf scars being arranged spirally on the stem.

The axis of the stem (pl. xvi. fig. 12) is composed of elongated utricles of various sizes, irregularly arranged, and having thin

walls marked with scalariform bars. This is so different a structure from the pith of a dicotyledon that it can only be compared to it from occupying the same position in the stem. It is surrounded by a compact cylinder consisting of long scalariform vessels, which somewhat increase in size from the inner margin to the outer, this increase being sufficient to meet the requirements of the enlarged circumference, with the addition of only a few series of vessels. As there is no true medullary cellular tissue in the axis, so there are no medullary rays passing through the woody cylinder; it is however penetrated by the vascular bundles which supply the leaves which have been mistaken for or misnamed medullary rays. The woody cylinder is surrounded by a great thickness of cellular tissue, which extends to the exterior of the stem and is composed of three distinct and separable layers. The inner zone has never, as far as I know, been perfectly preserved in any specimen, yet traces of it may be occasionally seen. Its absence arises from its extremely delicate structure. The cells of the middle zone have thicker walls, and have consequently more frequently resisted decomposition before fossilisation made them permanent. In the outer zone the cells are very much lengthened, and have a smaller diameter, resembling very closely true woody fibre. The cell walls of the three zones are without markings of any kind.

The vascular bundles which pass through the woody cylinder traverse these cellular layers to the leaves and branches. Each bundle consists of scalariform vessels very much finer than those of the wood of the stem, surrounded by elongated cells like those of the outer zone, and probably still further by a delicate parenchyma, which disappeared before it was fossilised. The only evidence I have of the existence of this cellular tissue is that the bundles never fill the cavities in the tissues of the stem through which they pass. The vascular bundles terminate in the points seen on the areoles of the stem, which are the scars of the bases of the leaves.

The woody cylinder is of different thicknesses in different stems, and appears to have increased with the growth of the tree; there is however no indication of interruption in the growth or of seasonal layers; but the whole cylinder could not have been developed at the same time. It is very probable that the zone of slender and consequently rarely preserved cellular tissue which surrounded the woody cylinder was analogous in its functions to the cambium layer of phanerogamous stems, like a similar structure which occurs in recent *Lycopodiaceæ*.

The leaves were simple, lanceolate, acute and sessile. They had a single median nerve. The younger branches were

densely covered with leaves; and the scars left on the trunk after they perished give the beautiful markings by which the different species are distinguished. The leaves when found separately are called *Lepidophylla*.

The fruit was a strobilus (*Lepidostrobus*) (pl. xvi. fig. 1) formed from a shortened branch, the leaves of which are converted into scales that support on their upper surface a single large sporangium (fig. 4), which appears to contain both macrospores (fig. 5) and microspores.

These sporiferous strobili can scarcely be distinguished in general appearance and arrangement of parts from those of some recent *Lycopodiaceæ*, except in the great difference of size, but their containing two kinds of spores indicates an affinity rather with *Rhizocarpeæ*.

Another cone (*Flemingites*, fig. 2), having the same external appearance, occurs in the coal measures though it has not yet been found connected with any supporting plant. Its sporangia (fig. 3) occur in enormous quantity in many coals, and the tree on which it was borne—probably one of the lepidendroid forms—must have been very abundant, and contributed largely to the formation of coal. It differed from *Lepidodendron* in having numerous small sporangia supported on each scale.

The structure of the stem also confirms the near affinity of *Lepidodendron* to our living vascular cryptogams. In general arrangement of parts they agree indeed more with *Cycadeæ*, and thus appear to support the views of Dawson in regard to *Sigillaria*, but the minute structure of the vascular tissue and the absence of medullary rays are much more important characters than the modifications in the arrangement of the constituent parts of the stem, which is often very different in the same order of plants. A comparison of the fossil arborescent trunk with the slender stem of a modern lycopod shows that the principal differences are the existence of a pseudo-medulla, and the arrangement of the vascular tissue as a solid cylinder in the fossil genus as against the central position and loose structure of the vascular tissue in the recent plant. In both the recent and fossil stems the vascular tissues are surrounded by a zone of thin walled cells, which has disappeared in all the dried specimens of *Lycopodium* I have examined, leaving the axis free, and which, as we have seen, is very rarely preserved in *Lepidodendron*.

Perhaps more genera have been established for the different parts of *Calamites* than for the fragments of any other fossil genus. The stem has been described as *Calamites*, *Calamitea*, and *Calamodendron*; the foliage as *Asterophyllites*, *Annularia*, *Hippurites* and *Sphenophyllum*, and the fruit as *Volkmannia*, *Aphylostachys*, *Huttonia*, &c.

The axis of the stem of *Calamites* (pl. xvi. fig. 13) was composed of cellular tissue, and this was surrounded by a solid cylinder of wood entirely composed of scalariform vessels, and without any trace of medullary rays. The vascular tissue was developed from a series of equidistant points near the circumference of the cellular tissue, and grew outwards and laterally until they united in a continuous cylinder fluted on the inner surface and with the flutings filled with the cellular tissue of the axis. A similar structure exists in the arborescent stems of some species of *Cactus*. There were constrictions at regular intervals in the woody cylinder, as in some recent *Artocarpeæ*. The wood was covered by a thin epidermal layer of parenchyma, which is less seldom preserved than the cellular structure of the axis.

The stem somewhat rapidly contracted at the base, the nodes shortening, and giving off long cylindrical roots which spread laterally through the soil.

The main stem was simple, but at intervals gave off whorls of slender branches, and these again bore branches or leaves also arranged in whorls. The leaves were capillary (*Asterophyllites*) linear-lanceolate (*Annularia*, and *Hippurites*) or cuneate (*Sphenophyllum*) and each whorl contained, in different species, from five to twenty leaves.

The fruit was a strobilus (fig. 7) composed of whorls of scales alternating with and protecting whorls of peltate leaves, which supported the sporangia (fig. 4). The spores were simple and not compound as in *Lepidostrobus*.

Various opinions have been entertained regarding the systematic position of *Calamites*. It was originally supposed that they were huge *Equisetaceæ*, from the jointed and fluted stems. But these characters, which have been always described as external, are really on the interior of the woody cylinder. *Calamites* occur fossil either as cylinders of coal, the empty cellular core filled with sand, clay, or other foreign substance, or more frequently as flattened stems with more or less foreign matter in the interior, or more rarely preserved in calcareous or ironstone nodules and preserving to some extent the original structure. When the plants were destroyed the cellular axis speedily disappeared, and the woody cylinder alone formed the layer of coal. The cast of the interior, which in time became harder than the vascular tissues of the stem, acted upon as it was by the water that saturated the deposit, resisted more successfully the pressure of the superincumbent deposits which in compressing the stem produced on its outer surface a counterpart of the furrows and constrictions of the internal cast. The outer surface of the stem was entirely free from these markings, so that the affinity to *Equisetææ* derived from them is valueless.

It is singular however, to find that after being referred by some to Gymnosperms, and by others placed among the *incertæ sedis*, the structure of the fruit shows that they really belong to the family to which at first, though on false observation, they had been referred. The stem, which as in *Lepidodendron* and *Sigillaria* in respect of their modern representatives, is anomalous when compared with the slender stems of recent equisetums, is yet only such a modification as would be required for arborescent forms of the order.

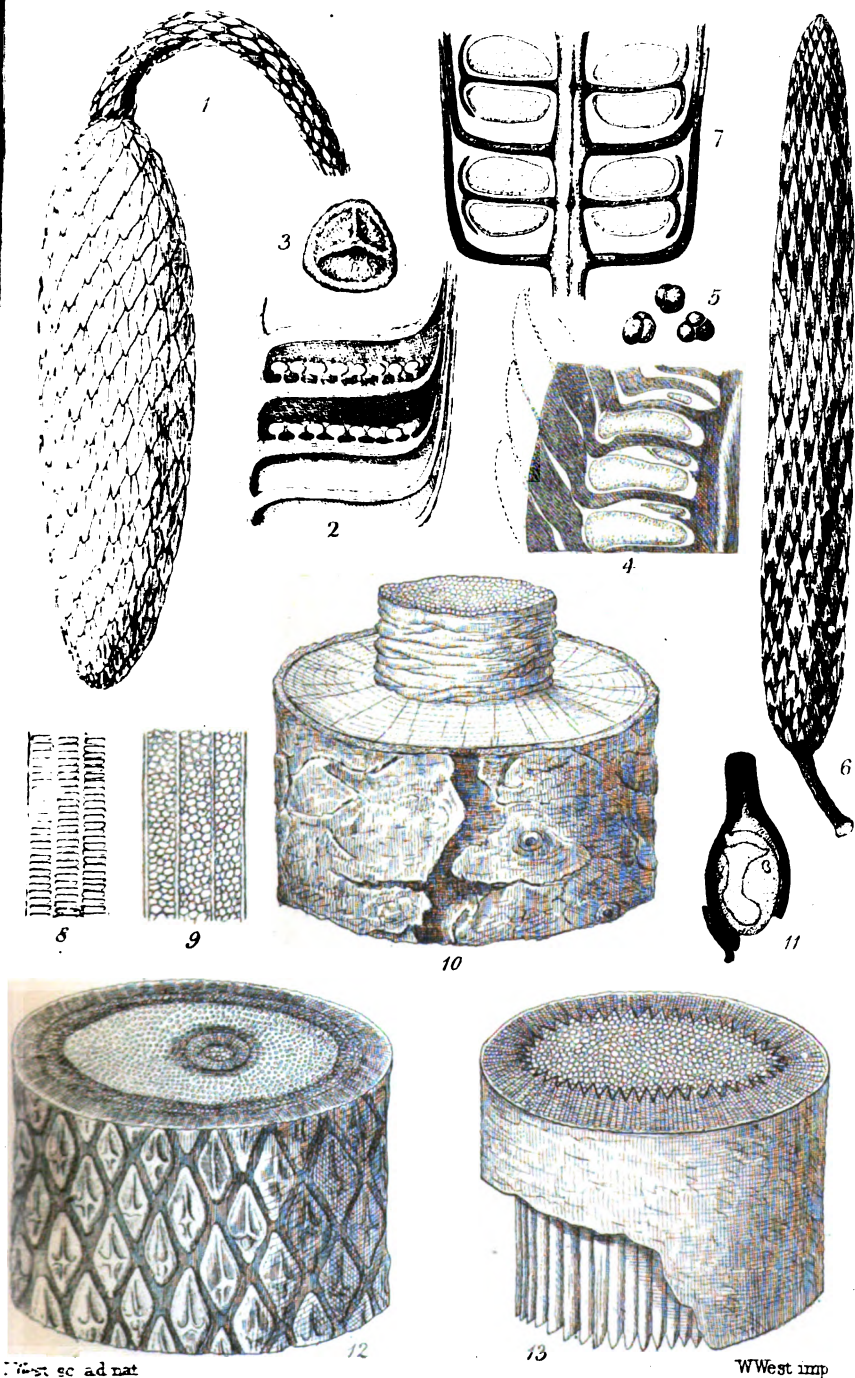
While the remains of *Coniferæ* as distinct and recognisable fossils are rare in the coal measures, the abundance of coniferous structures in the "mother coal" shows that they formed a considerable proportion of the forests which flourished during the Carboniferous period. Large trunks have been found in sandstone beds, and fragments in which the structure is more perfectly preserved, are occasionally met with in nodules in the shale or in the coal itself. These exhibit in transverse section (fig. 10) a large pith, and the annual rings of growth characteristic of perennial exogenous plants; and when cut parallel to the medullary rays, not only are the cells of the rays distinctly seen, but the disc-bearing tissue which is present in all known *Coniferæ*. The discs occur in several parallel rows, unlike the common conifers of the northern hemisphere, in which they are always in a single series. They have on this account been referred to the araucarian type in the woody structure of which the same arrangement exists. In some specimens, referred to *Dadoxylon*, the supposed discs are rather reticulations (fig. 9) on the wall of the vessel, without the central pore which is a necessary part of the true disc-bearing tissue. Hooker has further elucidated the affinities of these fossil conifers by describing a *Trigonocarpon* (fig. 11) which was preserved so as to exhibit structure. He gives satisfactory reasons deduced from its external appearance as well as its internal structure for considering it to be rather a coniferous fruit like the drupe of a *Salisburia*, than related to palms or cycads as had previously been supposed. He also points out the probability that the species of *Noeggerathia* described as the fronds of ferns, may have been the foliage of the same trees. So that here, as in *Calamites* and *Lepidodendron*, we seem to be able to construct from the scattered fragments this *Salisburia*-like conifer of the coal measures, finding its trunk in *Dadoxylon* or *Pinites*, its pith in *Sternbergia*, its foliage in *Noeggerathia* or *Cyclopteris*, and its fruit in *Trigonocarpon*!

The small number of genera, and even of species which have contributed to the formation of the beds of coal, is remarkable; and it is probable that the progress of research will even yet greatly reduce both, but especially the number of species. The

characters by which the different stems are distinguished are derived from variations in the arrangement and forms of the scars produced by the bases of the leaves. In recent tree ferns these vary in different parts of the same stem, and this may be expected to have been the case in the coal plants; and, indeed, Binney and Hooker have noticed the scars on which have been founded four species of *Sigillaria* existing on a single stem. The paucity of specific and generic forms reminds one of the extensive native forests of conifers, in the northern hemisphere, which consist of a very few, sometimes as in the Wellingtonia groves of only a single species, but the conditions under which they grew were very different. They covered extensive plains, growing on a wet, clayey soil. The temperature was not necessarily very high, nor the composition of the air different from what exists at present. The growth and decay of the forests were very rapid, and the changes indicated by the succession of coal, shale, and sandstone more speedily followed each other than one would at first suppose. Binney has observed an erect coniferous stem which has deposited around it some thickness of sandstone, a layer of under clay, a bed of coal, another of shale, and other successive deposits, all which were formed while it was a growing tree. Such a series of rapid changes, not produced by violent volcanic agency, is unknown in the present day. Both physically and botanically the coal measures present many remarkable problems to the naturalist.

EXPLANATION OF PLATE XVI.

- FIG. 1. Strobilus of *Lepidodendron*.—Natural size.
 „ 2. Two scales and sporangia of *Flemingites*.—Natural size.
 „ 3. Single sporangium of ditto, showing the triradiate base.—Magnified.
 „ 4. Two scales and sporangia of *Lepidodendron*.—Natural size.
 „ 5. Spores of ditto.—Magnified.
 „ 6. Section of Strobilus of *Calamites* showing the scales and the peltate scales, with sporangia.—Magnified.
 „ 7. Strobilus of *Calamites*.—Natural size.
 „ 8. Scleriform tissue from *Lepidodendron*.—Magnified.
 „ 9. Reticulations on the woody fibre of *Dadoxylon*.—Magnified.
 „ 10. Restored stem of *Dadoxylon*, with its large pith.—(Sternbergia.)
 „ 11. *Trigonocarpon*.—Natural size.
 „ 12. Restored stem of *Lepidodendron*.
 „ 13. „ „ *Calamites*.



REVIEWS.

A DICTIONARY OF SCIENCE.*

TWO years ago the first issue of Dr. Brande's Dictionary was commenced. The work is now completed, and we only wish we could add complete also. The general reader who looks at the long list of contributors to the Dictionary must feel satisfied that all that could be done to render the work perfect has been effected. When he finds that the various departments have been presided over by such distinguished authorities as Professor Owen, Dr. Frankland, Dr. Lindley, and Professor Hirst, he feels confident that no pains have been spared to meet the wants of those who consult a scientific dictionary. But when one conversant with the progress of modern science casts his eye over the pages of Brande's Dictionary he detects many objectionable features which a careful revision ought to have obliterated. As we stated when noticing the first few numbers of this work, we are not at all satisfied with the manner in which the department of Natural History has been dealt with. This branch is in point of merit far below all others except that of microscopy (if we may use the term), which has practically received no attention whatever. Professor Owen and Mr. Carter Blake are the writers responsible for this division of the Dictionary, and of the labour of these gentlemen we regret to be obliged to speak in anything but commendable terms. Whether Professor Owen's services have been merely nominal, or whether Mr. Blake's have been executive, it is not for us to offer any opinion. But this we must state in justice to our readers, the natural history sections of the work by no means represent the views of modern zoologists.

That our opinion is well founded the zoological reader may at once see for himself, by turning over the leaves of the Dictionary and reading the definitions of those terms which have reference to general Natural History and Physiology. Let us see for example what is stated under the heading of *Animal*. It is doubtless a very difficult matter to give an unimpeachable definition of an animal, and as this difficulty is appreciated by the zoologist, we should have expected nothing more from a writer than a very general and outline expression of the characters which serve to separate the animal from the plant. The writer of the article, however, does not experience the obstacles which most physiologists encounter; his views, we must con-

* "A Dictionary of Science, Literature, and Art." Edited by W. T. Brande, D.C.L. F.R.S., and the Rev. G. W. Cox, M.A. In 3 vols. London: Longmans, 1837.

fees, are, at all events, clear and decided. It would be pleasant if we could say as much for their accuracy. Professor Owen or Mr. C. Blake, we know not on whom the paternity of the definition lies, defines the term "animal" as follows:—"The name of the higher division or kingdom of organised beings *distinguished* by endowments of sensation and voluntary motion, superadded to the organic functions which animals possess in common with plants." The writer having given this cumbersome and valueless explanation, proceeds to deal with the objections which may be urged against it, and to our minds in a very unsatisfactory manner. He says that it might be thought that certain *confervæ* have the power of locomotion, and that in some plants a species of irritability is found, but these faculties in the instances referred to are more imaginary than real. No one, he says, can mistake the locomotion of a vegetable for that of an animal organism; the notion of vegetable sensation results from a confusion of the terms "irritability" and "sensation." Such an *ex cathedra* denunciation of the observant and discriminating power of those who are too cautious to pronounce at once as to the animality or vegetality of an organism, has a weight of its own, but its force is that of *brutum fulmen*. Is it possible that the writer can assert for one moment that the locomotion of the sponge—whose animal character is undoubted—is superior to that of the *volvox* or to that of the *diatomacæ* as pointed out by Schultze? If so we must give up the argument. Then again, when he talks so flippantly about confounding sensation with irritability, can he inform us what exact significance he attaches to either of these terms? If he can, he will do us a signal service by giving us the information, and he will confer a great boon on Modern Physiology. Of what value is zoological definition when dependent on asserted qualities which he who defines is unable to offer an intelligible account of? How, for instance, can we distinguish irritability from sensation when we know that in the case of a decapitated frog, the so-called property of irritability is to all appearance that of sensation? Professor Owen smiles at the untutored physiologist who can dream of comparing the movement of the sensitive plant with the motion of an animal, for, says he, "Experiment has shown that the intumescent parts of the *mimosa*, in which the irritable property is concentrated, move the leaf by an extension of cells and not by a contraction of fibres." This is plausible enough but it does not stand the test of analysis. How can Professor Owen suppose his "extension of cells" to take place without contraction? Surely if the movement of a continuous mass displays extension in one direction it must exhibit contraction in another, unless we suppose—which we cannot in the case in point—that a general expansion as by heat occurs. Moreover we would ask Professor Owen to bear in mind that the so-called contraction of his animal "fibres" is attended with a lateral extension. However, if we yield all these objections to the writer's dogma we still have the important fact that in the movements of the *Amœba*, there is no contraction of *fibres*, for the simple reason that there are no fibres to contract. This one fact is quite sufficient to refute the writer's argument. The other statements in the article in question are certainly opposed to our belief. We have yet to learn that every animal is provided with "an internal cavity" for digestion, as we know that certain species

extemporise a stomach, by, as it were, pushing their food into the substance of their bodies. We were not aware either, that all plants exhaled oxygen, or that all animals gave off carbonic acid; but it is well even in 1867 to have these hitherto debateable points clearly established. We must, however, raise our voice against the classification which places the *Desmidiæ* and Infusoria together as the lowest forms of animal life, and which ranges the former under the sub-kingdom Protozoa.

Passing to another branch of the subject we find the *Teredo* described as "a worm which enters wood in salt water, and there expands until it has attained the size of a finger." It is true that this information is given under the head of Boring-worm, but then as the paragraph contains no allusion to the Mollusca, and as the definition of the *Teredo* in another volume is never referred to, the casual reader of course carries away the valuable instruction that the *Teredo* is an annulose creature—a very common mistake, and one which a dictionary like Dr. Brande's should lose no opportunity of correcting. The *cirripeds* are defined to be "a class of fixed homogangliate animals," &c. Now what is the knowledge thus conveyed? the term homogangliate is seldom used now-a-days, and very few people understand that it refers to a symmetrical nervous system; but even assuming this knowledge on their part, how erroneous an idea is conveyed of the history of the *Cirripedia*, by the statement that they are *fixed* animals. It is idle to say in excuse that in other paragraphs the fact is conveyed that in their early life these creatures are free. The definitions should have been carefully framed, and not given piece-meal, as *disjecta membra*, scattered over the 3,000 pages of three large volumes. The *Ciliograda*—a bad term, we admit—is certainly not properly said to be a "tribe of Acalephans." By the term *Acalepha* the reader understands the functionally independent reproductive bodies of certain of the Hydrozoa, whereas if we mistake not, researches, not of a very recent character either, have determined the affinities of the Beroë and a Cydippe to be with the Actinozoa. On the same page on which this paragraph appears we notice one termed *ciliary*, in which to our utter astonishment we see no allusion whatever to the muscle of the name; the old word ligament is used, and its attachments are very incorrectly and imperfectly given. Why, we would ask also, is the class *Echinodermata* said to be a class of *Radiate* animals? Surely enough has been written upon the structure and development of these interesting animals to show that they should be removed from the Hydra and Actinia, with which they have no more structure in common than a man has with cuttle fish! Numerous similar examples of what we have alleged could be pointed out, but the few above given are sufficient, *ex uno disce omnes*. The orthography, too, is frequently very defective, and shows carelessness on the part of the scientific "reader;" of this we have instances, such as saccode for *sarcode*, *Lapadidæ* for *Lepadida*, *Palinurius* for *Palinurus*.

As to the manner in which microscopy has been dealt with, we can only say that little or no attention has been given to the subject. There is an article of about two or three pages upon the general principles of the microscope, but it is obvious that the subject could not have been properly treated in so short a space.

Elsewhere, we find one or two references to pieces of microscopic

apparatus, but the microscopist cannot fail to perceive that his interests have not received any consideration from the editors of the Dictionary. In the conduct of the other departments, we think the gentlemen employed to bring the dictionary up to the standard of modern science, have discharged their several duties with intelligence and discrimination. The work is a very valuable one in all respects but those to which we have drawn attention, but in these it is certainly "behind the time," and we cannot but regret that such a circumstance should exist to mar the usefulness of so admirably conceived a plan.

ICELAND.*

THIS work is the account of a tour made in exploration of the north-west peninsula of Iceland and the Vatna Jökul, and it would doubtless interest those of our readers who are of an exploring turn and are at a loss for a country in which adventure may be combined with a sufficient amount of danger to make it piquant and attractive. One of the author's objects was to investigate the ornithology of the island, and he has to a certain extent carried it out successfully. The bulk of the volume is occupied by the details of the trip. This is usual in books of travel, but for what earthly reason it is so, we cannot divine. We doubt if any one ever cares to wade through this part of a book. It is very tedious to read on page after page through a volume, and learn nothing except the number of eggs eaten by the author at his breakfast, or the difficulties which attended his repose. Mr. Shepherd, however, evidently thinks otherwise, and though one of his aims related to scientific investigation, the greater part of his book is filled with those "notes from my diary" which are so distressingly dreary to the—well we shall only say—reviewer. Passing by this portion of the author's lucubrations, we find toward the conclusion of the volume, a few details of scientific interest which we think may be profitably "crystallised out" from the rest of the letter-press. The following description of the sulphur-mountains is of interest: "These large hills are a very wonderful sight. They are of various colours, a variety of mixtures of red and yellow. From their sides are emitted numerous jets of steam, and masses of bright yellow sulphur are strewed all round them. At the foot on the eastern side are the mud-geysers—huge caldrons of blue mud in different states of solution. Some bubble and spurt like filthy water; others are so gross that they can scarcely heave the massive bubbles to the surface. They are the centres of broken and dilapidated cones, raised by their own sputterings. The highest part of their cones, which was that part towards the mountains, was about three feet. They are however continually changing in shape; and I observed that these portions of the cones themselves was (*sic*) different from what they were when I visited them in 1861. All around the soil was

* The "North-West Peninsula of Iceland." By C. W. Shepherd, M.A. F.Z.S. London: Longmans, 1867.

very treacherous, consisting of hot mud with a covering of sulphur about an inch in thickness, which in most places was about sufficient to bear a man's weight. When this crust was broken, steam issued forth, strongly impregnated with sulphur. The clouds of steam, the roaring, the spluttering, and the splashing of these loathsome pits, the sickening smell and the desolate country had somewhat of an awe-inspiring effect." Mr. Shepherd gives some instructive details of the habits of the Icelandic birds, and he has given some happy sketches of Icelandic scenery, which have been chromo-lithographed in Hanhart's best style.

THE ELECTRIC TELEGRAPH.*

THE excellent and well-known treatise of Lardner has been carefully revised and rewritten in accordance with the advance made of late years in the department of electrical physics. The task of editor was entrusted to Mr. Edward Bright, and the publisher may congratulate himself on the selection. The book is in most respects a good, sound, intelligible, practical treatise on the electric telegraph. It deals with the elementary principles on which the application of electricity to telegraphic purposes is based, the modifications of the original apparatus employed in various countries, the different forms of conducting cable, and finally of the uses—commercial, social, and political—to which the electric telegraph has been applied. There is one feature however, against which we must raise our voice: Electricity is described in the language of the popular lecturer as a "subtle fluid." This is extremely objectionable, and the more so as the editor is fully aware that the modern view of the force is opposed to such a mode of expression. Mr. Bright urges that the term fluid is the most convenient for the purpose of explaining electrical phenomena. In this we totally differ from him. In the first place the term so applied is erroneous, and in the second, the word wave would answer every purpose which is served by fluid. For the merely practical electrician, there may be no harm in employing the word fluid, but it must be remembered that Dr. Lardner's work as the chief popular treatise on the telegraph, goes into our schools and families, and is thus calculated to do a certain amount of mischief. Mr. Bright may not be familiar with the history of other sciences, but if he be, he must know how injurious to the progress of knowledge it is to hamper a branch of science with a term implying an hypothesis which has not one tittle of evidence to support it. Such expressions as "vital force" and "electric fluid," and such like, are stumbling-blocks to the progressive student. We have little doubt that had it not been for the adoption of such technicalities as electric-fluid, tonicity, and irritability, the action of the muscles

* The "Electric Telegraph." By Dr. Lardner. A new edition revised and rewritten. By E. B. Bright, F.R.A.S. Secretary of the British and Irish Magnetic Telegraph Company. London: James Walton, 1867.

in animals would long since have been admitted to be due to electric conditions, but scientific progress has been prevented by these barbarisms of hypotheses.

The descriptive portion of the book is, as might have been expected, remarkably clear and correct, and is full of anecdotal matter of an interesting and amusing character, so that pleasure and profit may be gained in its perusal. We would refer especially to the accounts given of the modern appliances by which the telegram is electrically printed at the "receiving station." No form of apparatus is omitted, and those varieties described are carried home to the reader's mind by the assistance of the admirable woodcuts which accompany the text. The chapter on the application of the telegraph in railway signalling, should be read by all who wish to know how it is that trains may follow each other at full speed, and at short intervals of time without the least danger of accident by collision. Of the immense advantage of the telegraph in railway operations, the following facts recorded in the present volume will amply demonstrate. "On New Year's day 1850 a catastrophe which it is fearful to contemplate, was averted by the aid of the telegraph. A collision had occurred to an empty train at Gravesend; and the driver having leaped from his engine, this latter started at full speed for London. Notice was immediately given by telegraph to London and other stations, and while the line was kept clear, an engine and other arrangements were prepared as a buttress to receive the runaway. The superintendent of the railway also started down the line on an engine; and on passing the runaway he reversed his engine and had it transferred at the next crossing to the up-line so as to be in the rear of the fugitive; he then started in chase, and on overtaking the other he ran into it at speed, and the driver of his engine took possession of the fugitive, and all danger was at an end. Twelve stations were passed in safety; it passed Woolwich at fifteen miles an hour; it was within a couple of miles of London before it was arrested; had its approach been unknown the mere money value of the damage it would have caused might have equalled the cost of the whole line of telegraphs. They have then paid, or in a large part paid for, their erection."

Dr. Lardner's book is full of other similar facts, illustrating the benefits which the telegraph has conferred on humanity at large. The description of the telegraph from the House of Commons to the Opera, shows what curious services electricity is made to perform. The progress of business in parliament is regularly reported in the Lobby. So that "Young England has only to lounge out between the acts to know if Disraeli or Lord John Russell is up, and whether he may sit out the piece or hasten down to Westminster." We have said enough to show the highly interesting character of Dr. Lardner's volume, and we now therefore leave it, trusting that our readers will take it up and judge of it for themselves.

movement of this plant. They are quite spontaneous and depend upon no common stimulus. The phenomenon displays itself at all periods of the day and night, and there are often weeks of repose. The leaves, large and small, seem to share in the motion, which is described as a sort of trembling. Vide *Comptes Rendus*, April 22.

CHEMISTRY.

Determination of Organic Impurities in Water.—Mr. Miles Smith has written a letter to our contemporary *The Laboratory*, in which he states that the investigations of Professor Wanklyn and Mr. Chapman have shown that the ordinary mode of determining organic matters by evaporation is erroneous. If this be so it is a most important discovery, and it shows us how unreliable must be the results of the analyses, so often published, of our metropolitan waters. Professor Wanklyn has called attention to the fact that the organic matters present in natural waters are liable to undergo decomposition during evaporation, and that consequently the organic constituents found in the dry residue left by a water are not to be taken as a just representation of the organic impurities originally present in the water. The nitrogenous organic impurities of waters are especially liable to change, and if the evaporation be made in the presence of a powerful alkali evolve their nitrogen in the form of ammonia. Wanklyn and Chapman propose to detect and estimate the nitrogenous bodies in waters by taking advantage of this reaction. In point of fact, they propose to make a kind of Will and Varrentrapp's analysis at moderate temperatures. The following experiments illustrate the qualitative application of the method. Artificial waters were made by taking distilled water and putting into it small quantities of well-known nitrogenised organic matters, and the artificial waters were then examined. First, however, it was shown that neither nitrates nor nitrites give ammonia when boiled with alkalies and sugar. To half a litre of distilled water were added some sugar, baryta water, and a nitrate, the whole being then boiled down rapidly in a retort very nearly to dryness. No ammonia was evolved. The presence of ammonia in these experiments was ascertained by means of Nessler's test, which is well known to be extraordinarily delicate. Nitrites treated similarly gave no ammonia. It was also shown that if a small quantity of an ammoniacal salt be taken and treated as above described, all the ammonia is evolved at the beginning of the evaporation, and towards the latter part of the distillation the distillate comes over perfectly free from ammonia.

Chemical Examiners to the London University.—Professor Williamson, Ph.D., F.R.S., and H. Debus, Esq., Ph.D., F.R.S., have been re-elected Examiners in Chemistry for the University of London. The salary of each office is 175*l.* per annum.

Illuminating Power of the Gas of various Cities.—In the lectures which Professor Frankland lately delivered at the Royal Institution, some very useful comparisons were made showing the relative illumination-values of the gas of different localities. Professor Frankland had the illuminating

power tested by the standard sperm candles, and the following are the results:—Berlin, 15·5 candles; Paris, 12·3; London, 12·1; Vienna, 9·0; Edinburgh, 28·0; Manchester, 22·0; Liverpool, 22·0; Glasgow, 28·0; Aberdeen, 35·0; Greenock, 28·5; Hawick, 30·0; Inverness, 25·0; Paisley, 30·3; Carlisle, 16·0; Birmingham, 15·0. Thus the gas supplied to Edinburgh and Glasgow gives more than twice the light of the gas provided for London. The above shows the average light given by the gas furnished in London; but, in particular instances, it only equals nine candles. The gas of London, also, Prof. Frankland stated, is richer [fouler?] than it ought to be in the sulphur compounds, and in burning gives off too much poisonous sulphurous acid and other gaseous vapours injurious to health and property. London gas is now worse than it was many years ago, although its methods of manufacture have been cheapened by the discoveries of science, all new inventions in this direction having been eagerly taken up by the gas companies, who, so far as is known, have not adopted a single invention which would benefit the consumer. The lecturer concluded by saying "gaslight should have an illuminating power of twenty candles, below which no gas is fit for household use!"

The description of Acetylene.—M. De Wilde describes a very interesting experiment in which acetylene is resolved into its elements (if we may use such an explanation of the phenomena) by means of the induction spark. He gives the following as the best mode of performing the experiment. Introduce the dry gas into a small eudiometer over mercury, and furnished with two platinum wires about four millimetres apart. At the passage of the spark, a light tuft of carbon is formed between the wires, and the action stops. Agitate the eudiometer, so as to cause the mercury to knock off the carbon, and the sparks which again pass will reproduce this phenomenon. The eudiometer is shaken as often as necessary for the continuation of the experiment. If operating with ten cubic centimetres of gas, from fifteen to twenty agitations will suffice; the experiment will then proceed uninterruptedly. In ten or fifteen hours all the acetylene will be decomposed. The remaining gas submitted to eudiometric analysis is found to be hydrogen. The acetylene should give its volume of hydrogen, but there is always a diminution of about a fifth, which may, perhaps, be attributed to the absorption of hydrogen by the deposited carbon, or perhaps, to the formation of some trace of condensed hydrocarbons. Vide *Bulletin de la Société chimique*, vi. 267.

Nature of the Earth eaten by the People of Borneo.—*The Chemical News* gives us the composition of the clay which is eaten so extensively by the natives of Borneo. It states that some years ago the manager of the Orange-Nassau colliery, near Zandjermasin, in the Island of Borneo, found that many of his workpeople (natives) consumed large quantities of a kind of clay; a sample of this material was forwarded to Batavia for analysis, and the following is the result in 100 parts:—

Pitcoal resin (organic matter volatile at red heat)	15·4
Pure carbon	14·9
Silica	38·3
Alumina	27·7
Iron pyrites	3·7
	100·0

Vide *Chemical News*, May 10.

Chemical Properties of Colchicia.—Mr. John M. Maisch publishes a paper on this subject in a recent number of the American Journal of Pharmacy. From an examination of a specimen of colchicia (the active principle of colchicum) in the Philadelphia College of Pharmacy, which was made with a view of clearing up the question of the reaction of this substance, Mr. Maisch gives the following as its chemical properties. The substance is a light yellow amorphous powder, possessing a very faint odour and intensely bitter taste, sparingly soluble in ether, but easily soluble in water and alcohol, the aqueous solution being slightly turbid, most likely in consequence of the decomposition of a small portion into resin and colchicein. Heated upon platinum foil, it fuses; at a higher heat, it takes fire and burns without leaving any residue. Placed upon moistened red litmus paper, the blue colour is restored; very faintly reddened litmus becomes blue also by a concentrated aqueous solution. One drop of dilute sulphuric acid dropped from a bottle giving fifty-two drops to the fluid drachm, consequently about one-eighth of a grain HO, SO_4 , when mixed with one grain of colchicia, retained its acid reaction. One drop of the acid was mixed with one fluid ounce of distilled water; in five minims of this mixture, equal to about one-seven hundred and seventieth grain HO, SO_4 , one-sixteenth grain colchicia was dissolved, and the solution now had a distinct alkaline reaction on slightly reddened litmus paper; but on heating this solution to the boiling point, it had acquired an acid reaction.

Electrolysis of Alkaline Sulphides.—In a paper which appears in the *Annalen der Chemie*, Herr H. Buff states that in the case of an electrolyte under the influence of the electric current, the groups of elements travel in opposite directions, carrying an equal amount of electricity of opposite nature; they are electric-equivalent. From his experiments with alkaline sulphides, the author concludes that the decomposition of the various mono- or poly-sulphides of potassium or sodium always takes place in this manner, that the metals travel towards the one electrode and all the sulphur towards the other, or that a group of, for instance, five atoms of potassic pentasulphide is electric-equivalent to one atom of potassic monosulphide.

Soluble Phosphates in Cotton-fibre and Seeds.—At a recent meeting of the Chemical Society, a paper by Dr. F. Grace Calvert was read in which it was pointed out that seeds contain relatively more mineral phosphates than other parts of the plants upon which they are borne, and which alludes to the common practice of burning off the organic matters before proceeding to search for the phosphates therein contained. From his experiments Dr. Calvert has, however, been led to conclude that the whole of the phosphoric acid or phosphates is merely held mechanically distributed throughout the organic tissue, and in such a condition that they may be wholly extracted by the action of water. Cotton yarn steeped for several hours in distilled water furnished a solution containing appreciable quantities of phosphoric acid, lime, and magnesia, and quantitative experiments were made upon seven characteristic varieties of cotton, which had been carefully prepared and carded in Manchester, for the purpose of determining the extent to which the phosphates could be removed by washing. The results showed by the uranium process amounts varying between .035 and .055 per cent. of phosphoric acid thus dissolved, whilst traces only of this constituent could

be detected in the ash left upon burning the washed and dried cotton. Similar experiments made upon wheat, French beans, and walnuts gave like results, much phosphoric acid and magnesia being discovered in the aqueous solution.

How to know pure Glycerine.—A writer in an American Pharmaceutical periodical makes the following remarks relative to the best mode of testing the purity of a sample of glycerine:—"I should regard a glycerine as unobjectionable for medicinal purposes, if it forms a colourless mixture with twice its volume of strong alcohol and of sulphuric acid; and if, after previous dilution with distilled water, it yields no turbidity, either cold or on heating to the boiling point with sulphuretted hydrogen, ferrocyanide of potassium, nitrate of baryta, oxalate of ammonia, or nitrate of silver. This last test I regard as an important one, since I believe that all those compounds, which impart to common glycerine a peculiar rancid odour, will reduce the silver salt and impart a colour to the liquid on boiling, even though that odour may be scarcely apparent, while pure glycerine is not affected by boiling with nitrate of silver, although, like nearly all organic and many inorganic compounds, it gradually assumes a darker colour on exposure to light.

Chloride of Silver in the Estimation of Iodine.—M. Kraut has devised a useful mode of determining the iodine contained in organic hydriodates, of which the *Chemical News* gives a short account. Herr Kraut digests the solution for several minutes with a known quantity of recently precipitated chloride of silver; the increase of the weight of the chloride of silver is in proportion to the amount of iodine. This method has the advantage of not altering the substance beyond the removal of its iodine, which is replaced by chlorine.—*Zeitschrift für analytische Chemie*, iv. 167.

A Chemical Method for effectually cleaning Glass is given in a recently published work on one of the processes of photography. It is simple, reliable and completely efficient, and will we doubt not be found very useful by our readers. It is as follows:—Dilute the ordinary hydrofluoric acid sold in gutta-percha bottles, with four or five parts of water, drop it on a cotton rubber (not on the glass), and rub well over, afterwards washing till the acid is removed. The action is the same as that of sulphuric acid when used for cleaning copper; a little of the glass is dissolved off, and a fresh surface exposed. The solution of the acid in water does not leave a dead surface on the glass, as the vapour would; if a strong solution is left on long enough to produce a visible depression, the part affected will be quite bright. This method is recommended in some cases for cleaning photographic plates. Vide the "Tannin Process," by Major Russell: R. Hardwicke, 192 Piccadilly.

Capillary Action and Chemical Decomposition.—The relation of the two phenomena has been well demonstrated in a recent experiment by M. Becquerel, who shows that both decomposition and combination are influenced by capillary attraction. He takes a tube with two branches reversed, and makes in it a fissure, the width of which is infinitely small. He pours therein a solution of nitrate of copper, and has found that no liquid passes by the fissure; but when placed in a vessel containing liquid protosulphuret of sodium, an electrical action takes place, and decomposition and recomposition ensue, manifested by the crystals which appear on both sides of the fissure. M. Becquerel has demonstrated the new and curious

phenomenon that the capillarity of the fissure has a real influence on the nature of the products of the decomposition; that the salts or the crystallisations are not always those indicated by theory; that the double decomposition often goes to the extent of reduction of the metal.—*Vide Comptes Rendus*, May 13.

Supposed Aniline Colours from Flesh.—Herr Erdmann fancies he has discovered a mode of producing the aniline dyes from flesh. Some time since he observed that a piece of roast veal had a reddish appearance on its surface. On transferring the red matter to various substances he found that under the influence of heat and moisture it increased in quantity. The chemical properties of the colouring matter to a certain extent resemble tryphenyl-rozaniline. The fact that large numbers of vegetable and other spores were formed with the red colouring matter is quite sufficient to account for the production of the colour. The new dye (!) is evidently of the same order as "showers of blood" and so forth, due to the development of low vegetable organisms.—*Vide Journal für Praktische Chemie*.

How to cover Flowers with Alum Crystals.—A trans-Atlantic contemporary describes a simple method of covering fresh-flowers with alum crystallisation. It is as follows:—Make baskets of pliable copper wire, and wrap them with gauze. Into these tie to the bottom violets, ferns, geranium leaves, chrysanthemums—in fact, any flowers except full-blown roses—and sink them in a solution of alum of one pound to the gallon of water, after the solution has cooled, as the colours will then be preserved in their original beauty, and the crystallised alum will hold faster than when from a hot solution. When you have a light covering of distinct crystals that cover completely the articles, remove carefully, and allow them to drain for twelve hours.

The Proportion of Acid and Sugar in ripening Fruit.—At the meeting of the Chemical Society, held on the 16th of May, an interesting paper by Dr. A. Dupré, upon the above important subject was read by the secretary. It has been stated by Continental chemists that, as the fruit ripens the acid (malic and tartaric) becomes converted into sugar. This is the point to which Dr. Dupré especially devoted his enquiries, and which he believes he has cleared up by showing that the Continental view is inaccurate. Dr. Dupré collected and experimented upon a hundred berries of Riesling grapes gathered at intervals of a month, commencing with September last, and the amounts of tartaric acid, free and combined, and also of sugar, were determined in the separated juices. The proportion of sugar increased in order of time from 2.08 to 12.10, and even to 16.20 per cent. in the juice of the perfectly ripe fruit; whilst the entire berries showed but a slight diminution or no appreciable change in the total amount of acid present. The saccharine matter could not, therefore, have been directly derived from the organic acid or its salts contained in the grape; but the author thinks it possible that the presence of such acid effects a change resulting in the production of sugar similar to that known to occur in the conversion of starch into sugar by the action of sulphuric and other acids. Further experiments, even more decisive in their character, were made upon Gutedel and Muscatel grapes, gathered at the same time and from the same vine, but in various stages of ripeness. In some of the unripe berries there was

absolutely no sugar, whilst in others nearly ripe 8·87 per cent. of sugar was found; but the amount of free acid estimated in a hundred grapes was almost the same in three samples of Gutedel, and actually increased with the ripening of the Muscatel.

The Water in the Bronze Vase found at Pompeii, upon which the *Daily Telegraph* was so eruditely classical, has been analysed. It was found perfectly limpid, and was hardly rendered turbid by a prolonged ebullition. At the temperature of 20° C. its sp. gr. is 1·001, about that of distilled water. The quantity of fixed matters left by evaporation was 1·032 gr. per litre. The gases disengaged by ebullition consisted of air and carbonic acid. Lime and magnesia were found in it; also phosphates in a small quantity; also some traces of sulphates, and even silica and iron. There was not the slightest trace of copper.—Vide *Comptes Rendus*, May 20.

GEOLOGY AND PALÆONTOLOGY.

The Formation of Gypsums and Dolomites.—At the meeting of the French Academy on the 22nd of April, Dr. Sterry Hunt, the celebrated Canadian geologist, read a paper on the subject. As usual he brought his profound knowledge of chemistry to bear on the questions discussed and he stated the following conclusions as resulting from his enquiries and investigations:—

1. That the mutual reaction of bicarbonate of lime and sulphate of magnesia gave rise to sulphate of lime and bicarbonate of magnesia.
2. That all the carbonates of magnesia arose from the decomposition of the primitive silicates, aided by atmospheric carbonic acid.
3. That a double anhydrous carbonate of lime and magnesia, having the composition of dolomite, can be produced by heating slowly, from 120° to 150° C., a mixture of lime and hydrated carbonate of magnesia.
4. That there are dolomites which contain greater or less proportions of magnesia, whether in the state of hydrated carbonate of magnesia or in the state of simple hydrate.

A New Volcano in the South Seas. From a letter forwarded by our consul at Navigators' Islands, we learn that a volcano has just broken out at Manua, about two miles from the islands of Olosca. It was preceded by a violent shock of earthquake, which commenced on the 5th of September, and on the 12th dense thick smoke rose out of the sea. Lava was thrown up, discolouring the water for many miles round, and destroying large quantities of fish. Wherever the ashes fell on the adjacent island they destroyed all vegetation. Up to the middle of November dense smoke was still being thrown up. It is said that the smoke rose higher than the neighbouring island, which is over 2000 feet high. The consul has been unable to ascertain whether there is any bank thrown up in the water.

A Deposit of Bituminous Gneiss.—At the last annual meeting of the Swedish Academy of Science, M. Nordenskiöld announced that a discovery of a large deposit of bituminous gneiss, 33 metres in thickness, embedded in layers of gneiss and mica-schist has been made in the hill of Nullaberg in Sweden. It is composed in addition to feldspar, quartz and mica of a

black substance which seems to be a hydro-carbon, and resembles coal. M. Nordenskiöld, stated that infiltration was impossible, and that therefore, there could be no doubt of the high antiquity of the strata of Nullaberg!

An International Archaeological Congress.—The "International Congress for Primeval History," which was founded a few years ago at Spezzia, is to hold its next meeting at Paris on the 17th of August next. The questions to be dealt with are the following:—1. Under what geological circumstances and among what plants and animals have in the different countries the oldest traces of man been discovered? What changes in the division of sea and land must have ensued since? 2. Were the caves generally inhabited? Were they inhabited by the same race and at the same periods? And, if not, how and by what characteristics are the inhabitants of the caves and the epochs to be distinguished? 3. Do the megalithic monuments belong to one people which by degrees overspread various countries? What were, in that case, the migrations of that race and its gradual progressive steps in art and industry? What relation may there possibly be between this race and the lake-dwellers who possess an analogous industry? 4. Is the appearance of bronze in the West the result of an indigenous industry, of violent conquests, or of the opening up of new channels of trade? 5. What are in the different countries the essential characteristics of the first iron period? Is this time anterior to historical times? 6. What information do we possess about the anatomical characteristics of the human races from the most ancient times to the iron period?

The Gold Mines in Canada according to the recent report of Dr. Sterry Hunt, appear to promise a fruitful harvest for investors. The gold-bearing rocks form part of the Laurentian area of Canada and New York, and Dr. Hunt states, that there is nothing in their age inconsistent with the belief that the mines will prove highly productive. All Dr. Hunt's investigations tend to show that the precious metal has a very wide range in Canada.

The Yorkshire Coal-question.—The question as to whether the experimental borings in Yorkshire are likely to prove the existence of coal in the "Eastern Levels," was discussed in a paper read before the Yorkshire Philosophical Society at one of its meetings in June. The paper contained an account of an attempt to discover coal at Reedness on the right bank of the Ouse, below Goole. In the discussion which followed, Mr. Wainwright made some remarks, showing that he had lately made inquiries in the neighbourhood of the borings, which had extended, according to the information which had been furnished to him by persons who were conversant with the matter, to a depth of 331 yards. He suggested that by an additional expenditure of 200*l.* or 300*l.*, they might ascertain whether any coal was there, and whether it would be worth while getting it.

The Tin Mines of Banca.—Banca is an island between Sumatra and Borneo, on whose tin-resources a fine work has been written by M. Van Diest. This latter has been translated by Dr. Le Neve Foster, and it contains the following conclusions interesting to mining geologists:—"1. In Northern Banca tin occurs in the granite in various ways and over a large extent of country. 2. The rocks which surround the granite are impregnated with ores and other minerals occurring in the granite for some distance, usually not more than a mile and a quarter. 3. These minerals

and ores are chiefly deposited in little veins or bunches in the direction of the planes of bedding or in the joints. 4. It is chiefly the sandstone which has taken up these minerals, especially where the rock appears to be the most metamorphosed."

The Carboniferous Coal of Russia.—A monograph on the coal of Russia has been published at St. Petersburg. It is by Lieut.-General de Helmerson, and among other facts, it gives the distribution of the coal of the Carboniferous age. This distribution is as follows: 1. On the eastern and western slopes of the Oural mountains. 2. In the governments of Novgorod, Iver, Moscow, Kalouga, Toula, and Riazan. The coal occupies a large elliptical basin, six hundred versts in length and four hundred in width, in the centre of which the town of Moscow is situated. 3. In Samara, a little peninsula formed by the river Volga, near Stavropol; and 4. In the government of Ekaterinoslav, where the coal-beds form a chain of low mountains called the Donetz, and are associated with abundant deposits of iron, which latter have not at present been worked for economic purposes; though they would well repay the cost.

The Perforations in Spirifer Cuspidalis.—Professor W. King does not yield his opinion on this point. He still contends that there is every probability of the existence of perforations in the shell of this species. He states that an imperfect testiferous specimen now in the Geological Museum of Queen's College, Galway, displays under a hand magnifier, here and there, particularly on the protective parts—as the medial furrow—patches of faint, slightly-raised oval impressions. He does not mean to have these appearances accepted as positive evidence of the existence of perforations, but he thinks they bear so strong a resemblance to rather ill-defined markings, undoubtedly arising from perforation often seen on metamorphosed specimens of *Delasma hastata* and other allied carboniferous species, in their force and arrangement as to render the existence of such a structure extremely improbable. Vide *Geological Magazine*, June.

The Phosphate of Lime Bed in North Wales.—Mr. D. C. Davies has sent an account of this curious deposit to the *Geological Magazine*. Our readers will remember that Professor Voelcker called the attention of Agriculturists to this bed, two or three years ago. The bed occurs in the midst of what Mr. Davies has already described as the middle or principal band of the Bala limestone. It was first discovered at Cwmgwynnen but it has since been found to extend for about two miles in a north-easterly direction and for about the same distance in a south-westerly line. It has been worked somewhat extensively at Cwmgwynnen, and here it may be studied best. It is black in colour, has an average thickness of about fifteen inches, and occurs in a *bed*, and not as a *vein*, as is sometimes stated by chemists. There are plenty of traces of former life in the bed: thus, Mr. Davies has obtained from it numerous casts of *Modiola*, *Aviculopecten*, *Orthoceras*, *Orthis*, *Lingula*, and fragments of Trilobites; but the fossils are not well preserved, their organic structure having apparently been destroyed by chemical agency. Mr. Davies regards this Phosphate bed as the remains of a Laminarian zone of sea life, just as the wide stretching, ferruginous sandy fossiliferous layers, in the same formation, with their fossils often broken and confusedly huddled together, are the remains of the Littoral zone of the same period. The bed,

as far as it has already been explored, gives an area of four miles long, by about eighty yards in width—this being the depth to which it is worked at Cwmgywynnen, in the nearly vertical strata, and at all points hitherto examined it maintains much the same dimensions.

The Origin of Petroleum.—The last number of the *Canadian Naturalist* contains an abstract of a recent paper by Dr. Hunt, in which the author alluded to the subject of the origin of petroleum. Dr. Hunt regards the process by which animal and vegetable hydrocarbonaceous tissues have been converted into solid or liquid bitumen, as a decay or fermentation, under conditions in which atmospheric oxygenation is excluded, so that the maximum amount of hydrogen is retained by the carbon; and as representing one extreme of a process, the other of which is found in anthracite and mineral charcoal, the two conditions being antagonistic, and excluding each other, and the production of petroleum implying, when complete, the disappearance of the organic tissue. Hence pyroschists, the so-called bituminous shales, and coal, are not found together with petroleum, but in separate formations, and it is to be borne in mind that the epithet bituminous applied to the former bodies is a mistaken one, since they seldom or never contain any bitumen, although, like all fixed organic bodies, they yield hydrocarbons by destructive distillation. The fallacy of the notion which ascribes petroleum to the action of subterranean heat on coal was exposed by Dr. Hunt, who stated that the oil of the Trenton limestone occurs below the horizon of any pyroschists or other Hydrocarbonaceous rocks.

Eozoön Canadense.—Dr. Dawson lately presented a paper on certain discoveries in regard to the above fossil, before the Montreal Natural History Society. He also exhibited a photograph of a remarkable specimen of *Eozoön Canadense*, found during the past summer in the Laurentian limestone of Tudor, Canada West, by Mr. Vennor. The rocks at Tudor and its vicinity, which, according to the observations of Mr. Vennor, are Lower Laurentian, have experienced less metamorphism than is usual in formations of that age. And this peculiarity gives especial interest to the present specimen, which is contained in a rock scarcely altered, and in a condition not essentially different, from that of ordinary Silurian fossils. The matrix is a coarse laminated limestone of a dark colour, and containing much sand and finely comminuted carbonaceous matter. The fossil itself is of a flattened clavate form, about six and a half inches in length, and with the septa of its chambers perfectly preserved, exhibiting on one side a well-defined marginal wall, produced by coalescence of the septa, and apparently traversed by small orifices. Under the microscope the minute structures of *Eozoön Canadense* can be detected, though less distinctly perceived than in some of the specimens mineralised by serpentine. In some of the chambers there are small amorphous bodies containing pointed silicious spicules, which seem to be the remains of sponges that have established themselves in the cells after the animal matter of *Eozoön* had disappeared.

The Classification of the Drift Deposits.—Mr. Binney writes to the *Geological Magazine* for May, to comment on Mr. Hull's attempted classification of the drift deposits of Lancashire and Cheshire. He states that 25 years since he gave the following classification of these deposits to the Manchester Geological Society:—1. Beds of stratified and unstratified

gravel and sand, containing well rounded pebbles of primitive Primary and later Secondary rocks. 2. Till, a thick deposit of marl or brown clay, mixed with angular or rounded pebbles of various sizes without any order of deposition. 3. Beds of stratified fine rolled gravel and forest sand, often containing beds of clay or loam. 4. Deposits of gravel and sand, both stratified and unstratified, found in the beds of valleys and low lands adjoining rivers and brook courses. In addition to the above a bed of rich loam is frequently found in the valleys, covering the last named deposit. Still he thinks it very difficult to arrive at any satisfactory classification. In evidence of this opinion he gives the following section of the deposits at Broadstairs Colliery, near Hyde, which we confess it would be difficult to classify satisfactorily:—

	ft.	in.		ft.	in.
1. Clay	11	0	8. Quicksand and Loam	6	0
2. Quicksand	2	6	9. Gravel	3	0
3. Strong Marl	22	6	10. Loam	7	6
4. Quicksand	2	6	11. Gravel and Sand	3	0
5. Loam with Pebbles	12	6	12. Clay and Loam	15	6
6. Buck-leaf Marl	19	0	13. Gravel and Soft Marl		
7. Dry Sand	9	0	containing Pebbles	10	0

Local Sandstones.—At a late meeting of the Geological Society of Glasgow Mr. J. Wallace Young read a paper on this subject, in which he expressed the following conclusions: 1. That in the greater number of sandstones examined, the cementing material consisted of carbonates. 2. That very considerable quantities of the carbonates of iron and magnesia frequently accompanied the carbonate of lime, although no definite ratio seemed to exist between them. 3. That these sandstones were harder the greater the proportion of carbonates they contain. 4. Mica was found to be present in nearly all those examined, and, with one exception, was of the white variety. 5. Soluble silicates were only found in three varieties, in any quantity, all three belonging to the Old Red Sandstone; 6. That the different shades of colour seen in those sandstones belonging to the last-mentioned rocks appeared to be due solely to the peroxide of iron, and that the white rings and spots so often observed have resulted from the reduction and subsequent removal of the greater part of this iron.

Hungarian Oligocene Deposits.—Herr Hantken has presented a paper to the Viennese Geological Institute on the subject of some oligocene strata which have recently been exposed in a shaft sunk at Sarisap in Hungary. The strata are about 160 feet thick, and are of marine and brackish origin. The beds due to the latter are composed of a sandy plastic clay, containing shells and seeds of *Chara*. The marine strata overlie the brackish water ones, a bed of clay intervening between the two: 60 feet of sandstone are above the clay, and contain the remains of *Echinide*.

Cycadoidia Yatesii is the name given to a newly discovered cycad, which has been carefully examined by Mr. Carruthers of the British Museum. The specimens from which the description has been given, were found in the iron and green sands of Potton which rest on the Kimmeridge and Oxford clays and are covered by the Gault. The specific name has been given in compliment to Mr. Yates, whose name is well and favorably known in con-

nection with the order of plants to which the species now founded belongs. The fossil belonged to an arborescent cycad resembling in aspect the tall cylindrical stems of *Cycas* or *Macrozamia*, and differed in this respect from the spherical or ovoid trunks belonging to the genus, which were described by Buckland and Lindley. The cellular axis was relatively very large. The pith has disappeared, except in one of the specimens, where there are still some indications of it, and of the vascular bundles which abounded in it. The woody cylinder surrounding the pith consists of two rings, everywhere pierced by medullary rays, which are often so large as to separate the rings into numerous series of woody wedges, as in recent *Cycadeæ*. The presence of discs on the woody vessels has been detected both by Professor Morris and Mr. Carruthers. The inner surface of the woody cylinder is marked by numerous narrow grooves and perforations, formed by the vascular bundles, as they passed from the pith into the wood. The outer surface has similar scars, produced by the vascular bundles, which passed from the wood to the leaves; but they are here larger and more regularly disposed than on the inner surface. Between the wood and the bases of the petioles there interposed a very thin layer of cellular tissue, through which the vascular bundles passed in an upward direction towards the petioles.

MECHANICAL SCIENCE.

Institute of Naval Architects.—During the month of April this Institute held its annual meeting, and, as in preceding years, some of the papers were of the highest scientific interest. Mr. I. R. Napier read a paper on some steel tug-boats constructed for the Godavery, having the extraordinary proportions of 140 ft. length, 25 ft. breadth, and only 1 foot draught. The plating is of galvanised steel with a view of reducing to the utmost the weight and frictional resistance and securing durability. An awning or roof, also plated with steel is provided, forming an integral part of the structure, being connected with the bottom by lattice-frames, so as to increase the depth, resisting bending strains, and thus to render the vessel rigid. The engine has a pair of 11-inch cylinders, 4-ft. stroke, supplied with steam at 160 lbs. pressure, from a tubular boiler, of the locomotive type. The paddles are at the stern, and the propelling surface is not less than $\frac{1}{10}$ of the augmented surface. It is thought that the speed may reach 12 miles an hour.

In a paper on the Stowage of Merchant Vessels by Mr. Barnaby, a practical plan was suggested for ascertaining the crankness or stiffness of the vessel, due to loading. Mr. Barnaby suggests the securing the ship to the wharf-side, by a chain with a slip, when she is lifting with the tide. Having thus been heeled over a few degrees she is to be suddenly released and the oscillations in a given time counted. In some experiments on the "Madeline" yacht, the shifting of a weight of 6.6 cwt. on the mast caused the time of 5 oscillations to vary from 21 to 26 seconds.

Mr. Bourne described a system of designing the water lines of ships, so that the lateral displacement of the water for a given progress of the vessel should obey the same law as to velocity as a pendulum.

Two very important papers on apparent negative slip of screw propellers were read, one by Professor W. J. M. Rankin, and the other by Mr. W. Froude. In the former, the existence of negative slip is explained by the fact, that the position of the propeller places it in the crest of a following or filling wave under the ship's counter, so that the water which the screw lays hold of has a temporary forward velocity over and above the permanent velocity of the *wake*; that temporary forward velocity may be many times greater than the permanent velocity of that current whose momentum is equivalent to the resistance of the ship; and thus any amount of negative slip may be accounted for. In Mr. Froude's paper the negative slip is attributed to the action of the screw on the *dead-water* carried by the ship in front of the stern-post, and which water has to be suddenly removed twice at least in each revolution of the screw. The block of dead-water thus carried, in the screw-well of a timber line-of-battle ship, is estimated at from 5 to 6 tons. Its dispersion, as the blade of the propeller sweeps past the stern-post, is accompanied with a violent shock on the screw-shaft, whilst the dispersed dead-water is instantaneously replaced by a fresh volume, to which the velocity of the ship must be rapidly imparted; and the communication of velocity to the water of replacement forms an adventitious addition to the ship's resistance. In this struggle between the propeller and the dead-water, although a precise balance is maintained between the propulsive shock delivered and the adventitious resistance called into play, yet a great deal of force is exerted to no purpose by the propeller and the mean speed of rotation of the propeller must undergo great reduction, in such a manner as to be capable of exhibiting, in almost any degree, the phenomenon of negative slip. In other words, whilst in reference to the speed of the propeller whilst acting in the free-water outside the dead-wood, the slip is always positive; in reference to the mean speed, including the retardations in passing the dead-wood, the slip is negative. Mr. Froude suggests as a means of testing his theory, the chromo-metric registration of the speed of rotation of the screw shaft, and as a means of obviating the sources of loss which his theory indicates, he would place the propeller not merely abaft the rudder but at some tangible distance clear of it. In some small scale experiments Mr. Froude obtained a result from thus removing the propeller equivalent to doubling the horse power.

Captain L. G. Heath R.N., who has had great opportunities of observing the effect of shot on targets, proposed a new system of armour-plating, in which the more or less perishable wood-backing is entirely dispensed with. He places the armour-plate, made as heavy as possible, on horizontal girders, so as to carry it about 14 inches in front of the ordinary skin of the ship, leaving an air space of that depth between. He anticipates that shot will be broken up in passing through the armour-plate, and will merely splash the vital part.

During the meetings drawings of a self-registering floating apparatus, for measuring the height of waves, was exhibited; the instrument having been contrived and used with success by Admiral Paris, of the French Navy.

Channel Ferry.—We mentioned in our last number, the proposed tunnels between this country and France. Messrs. A. and I. Inglis have now published, as a more feasible scheme, the details of a ferry steamboat of

440 feet length and 57 ft. beam, on which the railway cars could be run bodily, and which, from her great size, would be steady enough to obviate the danger of sea sickness. The engines proposed are oscillating engines of 1500 collective horses' power, and the passage between Dover and Calais would be made in one hour.

Mechanics of Flight.—An extremely interesting paper on this subject was read by Mr. Wenham to the Aeronautical Society. The subject is too difficult and complex to be explained briefly, and therefore we will only say that Mr. Wenham has brought into the explanation of flight, the effect of the forward motion in retarding descent. Imagine a parallelogram 10 ft. long by 2 ft. broad, weighing 20 lbs. Such a body would descend in still air at the limiting rate of 1,320 ft. per minute, the resistance of the air put in motion by the plane balancing at that velocity the effect of gravity. If now a force be applied horizontally so as to carry the plane with its long side forwards at a speed of 30 miles per hour, then the motion of the plane being both downwards and forwards, a great volume of air will pass under the front margin of the plane, and will be *carried downwards* before leaving the hinder margin. The weight of air thus put in motion will be enormous, and the descending velocity of the plane proportionately reduced. Mr. Wenham calculates that the velocity of descent would in these circumstances be reduced to $\frac{1}{3}$ of the passive rate of descent, or would not exceed 83 ft. per minute. Each particle of air would then be moved downwards $\frac{1}{30}$ of an inch by the passage of the plane, and conversely if this inclination were given to the plane it would move forwards without descending. Mr. Wenham finds that few birds can raise themselves vertically in the air, the exertion in that case being excessive. The eagle can only lift itself from the ground, by running with outstretched wings till its velocity having become sufficient, it glides into the air as if sliding on a frictionless plane.

Electric Loom.—In one of the looms in the Paris Exhibition, electricity has been applied in a most ingenious manner to effect the immediate stoppage of the loom on the breakage of a thread, the emptying of a bobbin, or other trifling accident requiring the notice of the attendant.

Type Writing Machine.—Mr. John Pratt, of Alabama, U. S., has recently brought out a machine for type writing, which was exhibited at the recent Soirée of the Institute of Civil Engineers, and which promises to be of much service. The writing is effected by pressing a series of keys like those of a piano-forte, which move into the necessary position a square frame carrying the type, and the letter is then impressed on the paper, by the stroke of a hammer, pressing the paper and an interposed carbonised sheet against the type. A document can be printed by the machine in about half the time necessary to write it in the ordinary way. Mr. Pratt thinks that if the machine comes into use it can be manufactured for three guineas, so simple and compact has it been made. A machine for stereotyping on a similar method, also the production of American ingenuity, is exhibited at Paris.

Steel Armour Plates.—Renewed experiments have been made on steel as a material for armour-plating, and have been attended with more success than heretofore. The plates tested were 9 ft. by 4 ft. by 7 ins. They consisted of interposed laminæ of iron and steel, and appeared to be welded

perfectly solid. In almost every case they were completely perforated by the 7-inch gun, with Palliser chilled shot, and charges of 15 to 20 lbs. of powder. One iron and one steel-faced plate resisted complete perforation, with the smaller charge, and the most that can be concluded at present is, that the laminated steel and iron plates exhibit equal resisting powers to the best rolled iron plates hitherto produced. It is remarkable that the chilled hot which penetrated but did not get through the plates remained perfect and unbroken.

Flow of Solids.—M. Tresca has explained to the Institute of Mechanical Engineers, now holding a meeting at Paris, his views on the flow of solids, to which we have before alluded. The experiments on which M. Tresca's theory is founded are of this nature. If a hollow cylinder closed at the bottom end, have a cylindrical block of lead fitted to it, and the hollow cylinder have a round hole in the centre of the bottom, a powerful pressure on the top of the block will produce a cylindrical jet of metal, having a section equal in area to the hole in the cylindrical vessel. If the solid block be replaced by a series of parallel laminæ of the same substance, and a section of the block be made after the pressure has been applied, it will be found that the laminæ, though compressed, remain parallel and flat over all the surface excepting that affected by the formation of the jet, and the jet itself will be found to consist of a series of cylindrical envelopes or tubes, one for each lamina of the original block. The same results have been obtained by M. Tresca with tin, silver, copper, aluminum, iron, steel, and other substances. If a series of holes be made in the bottom of the containing vessel, then a series of jets are formed, but each jet more or less affects the formation of the others. M. Tresca has similarly studied the flow through lateral orifices and the unequal distribution of pressure in the mass, due to the flow, and he has applied these results to explain the operations of forging and rolling. By oxidising specimens of rolled and forged iron, he found that all the elements of the original piece are drawn out in parallel lines, from the surface to the centre of the bar; precisely as in the case of the jets produced by pressure; so that, the changes of form produced by forging may be considered as the results of successive flowings, effected by each of the individual forces exerted on the work forged. These changes of form take place from particle to particle according to a geometrical order which admits of mathematical calculation. And the theory may thus supply definite rules for metallurgical operations. An abstract of the paper, which is extremely interesting, will be found in the *Engineer* of June 7.

MEDICAL SCIENCE.

Development of Fungi in the Kidneys.—In the last number of *Beal's Archives*, Dr. M. Tonge gives the details of a curious case of Phthisis, accompanied by the development of fungous growths in the substance of the kidney. The pelvis of the left kidney was filled with a yellowish-white

pultaceous substance adherent to the apices of many of the pyramids. Microscopical examination of this proved it to consist of the sporules and mycelium of a microscopic fungus, apparently a species of *oidium*, which had the following characters:—1. Round or oval vesicles, single or grouped, containing one or more globules (probably oil globules or minute sporules), and sometimes granular matter. 2. Elongated vesicles united at their ends so as to form continuous cylindrical tubes branching dichotomously, sometimes terminated by strings or groups of round or oval cells, lateral development of these cells being also not uncommon. The tubes contained oil globules and granular material. In some instances it could be perceived that the tubes were empty, the liquid material having escaped.

Action of Hydrosulphuric Acid on the Blood.—The observations which were some time since made by Herr Hoppe-Seyler have been fully corroborated by the more recent inquiries of Herren Kaufmann and Rosenthal. These physiologists assert that the action of the above gas is simply to asphyxiate. The remedy suggested in case of poisoning is introduction of oxygen into the blood by means of artificial respiration.

Absorption of Fat.—According to the observation of Herr Letzerich, fat and albumen are not absorbed by the epithelium of the intestine, but by vacuoles between the epithelial cells, which lead directly from the intestine into the lacteals. Fat in the epithelium he considers pathological, and generally due to excess of fat in the food.—Vide *Virchow's Archiv*, xxxvii.

Cervical Ribs.—In one of the late numbers of *Virchow's Archiv*, M. Stieda of Dorpat, describes an interesting case of the above. The case was that of a woman, aged 30, and has been reported in the *Journal of Anatomy*, No. 2. Except that the left cervical rib was ossified to its vertebra, whilst the right was articulated to it by a moveable joint, both ribs closely resembled each other. In each a head, neck, tubercle, and body, were found; the anterior end of the body was pointed and connected by a ligament to a plate of cartilage attached to the anterior end of the first thoracic rib. The subclavian arteries had been removed, so that M. Stieda could not determine their relations. The thoracic vertebræ and ribs, and the lumbar vertebræ, were normal in number.

Absorption by the Skin.—A memoir on this subject has been laid before the French Academy, by M. Ch. Hoffmann. His experiments have been made on digitalis, iodine of potassium, and chloride of sodium. He comes to the following conclusions:—1. Chemical and other agents, dissolved in water, penetrate slowly but obviously into the animal economy, by the external integument, and it is only when the blood and other fluids are saturated by them that the organism expels them. 2. All medicaments are not absorbed in the same degree. 3. The contradictory results hitherto obtained result from the insufficient length of the time devoted to the experiments.

Action of Compressed Air on the Circulation and Respiration.—M. Vivenot concludes from his experiments that the action of compressed air is to diminish the frequency of the pulse. This slackening is, on the average, about six and a half pulsations per minute. The cause is purely mechanical: the increase of pressure on the surface of the body diminishes the calibre of the small vessels, and increases the obstacle which the vascular walls oppose to the current from the heart. This diminution of the vessels may be seen

on the conjunctiva, on the ear of the rabbit, and on the vessels of the retina. Rarified air gives opposite effects. On the respiration, it produces a double effect; 1. an augmentation of capacity of the lungs—a mechanical dilatation; 2. the introduction of a larger quantity of air, since not only the lung has greater capacity, but the air is compressed. Compressed air, the author thinks, therefore, a useful agent in the treatment of certain diseases (emphysema, atelectasis, tuberculosis, pleuritic effusions, etc.); and so much the more valuable, that no other agent is calculated to fulfil the same indication.—*Virchow's Archiv*, 1886.

Obituary.—We regret to have to announce the death of two of the most illustrious members of the French profession, M. Jobert (de Lamballe), and M. Civiale, the inventor of lithotripsy.

Crystals in the Blood, in Leukamia.—Professor Neumann of Königsberg, communicates a paper on this interesting pathological subject to Max Schultze's *Microscopical Journal*. The formation of the crystals did not occur until long after the blood had been drawn. A large number of crystals were formed on each drop of blood. These were brilliant delicate symmetrical needles, which were found on minute examination to possess the form of an elongated octahedron. Some which appeared to be incompletely formed represented merely a four-sided pyramid with a rounded base. The length of the perfect crystals varied between 0.016 and 0.075, and the angles of the optical longitudinal section were between 18° and 162° . The crystals were insoluble in cold water; in boiling water they disappeared, but whether by solution or disintegration the author could not decide, but is inclined to think the latter, as he never observed any recrystallisation on cooling. Neither alcohol, ether, chloroform, nor glycerine, even after long exposure, had any effect upon them. Acetic, tartaric, and phosphoric acids slowly dissolved them, as did also very weak solutions of soda and potash. The action of the mineral acids was peculiar; hydrochloric and nitric acid in strong solutions dissolved the crystals, which withstood the same acids in the concentrated form, in which, however, they become apparently softened and were usually bent into an S form, or became crescentic. Strong sulphuric acid destroyed the crystals, which remained unaltered only in a moderately weak solution. Ammonia dissolved the crystals very slowly; they were unaffected by the putrefaction of the blood even after several weeks.—*Vide Quarterly Journal of Microscopical Science*, No. xxvi.

The Removal of Opacity of the Cornea.—Some very curious facts relative to the action of sulphate of soda on the cornea, are pointed out in a memoir just read before the French Academy by M. De Luca. This *savant* had tried the *Vinum Opii* and other remedies so much employed in treating opacity of the cornea, but found their results unsatisfactory. It then occurred to him that as sulphate of soda retains the fibrine of blood in solution, it might have the effect of dissolving away opaque portions of the cornea. At first he tried the experiment with solution of the sulphate in distilled water. This fluid he dropped into his patient's eyes, and the results were found, to a certain extent, satisfactory. Believing that the solid sulphate would produce still better results, he employed it in the state of very fine powder; dropping it into the eye of the patient. This method proved to be the most effectual, and if we are to believe M. De Luca, it was most suc-

cessful. In one or two cases where the opacity was so decided as to produce nearly total blindness, a considerable amount of vision was restored to the patient.—Vide *Comptes Rendus*, May 27.

Isolation of Pseudomorphine.—Pseudomorphine was discovered about thirty years ago by Pelletier, but from the exceedingly small quantity obtained by him, he was unable to give an exact method for its preparation. This, however, has now been done by Herr Hesse, who has published a paper on the subject in the *Annalen der Chemie*. Hesse finds that it accompanies morphine in Gregory's method, and may be separated from that body by adding excess of ammonia to the alcoholic solution of both alkaloids; the morphine is precipitated, the other remains in solution. Pseudomorphine is tasteless, insoluble in water, alcohol, ether, chloroform, carbonic bisulphide, and dilute sulphuric acid, easily soluble in potash, soda, or lime solutions, and in alcoholic solution of ammonia, sparingly so in aqueous solution of ammonia; it does not neutralise the acid reaction of even the smallest quantity of chlorhydric acid; it dissolves in concentrated sulphuric acid with an olive green, in concentrated nitric acid with an intense orange red, in ferric chloride with a blue colour. At 120° it loses 2 eq. water of crystallisation; at higher temperatures it turns yellow and decomposes without melting.

The Physiological Action of Digitalis has recently been very fully investigated by M. Legroux, who has thus formulated the conclusions at which he has arrived:—1. If given in a poisonous dose, digitalis acts directly on the heart; in a therapeutic dose, it excites primarily the contractility of the capillary vessels, and only secondarily influences the circulatory centre by re-establishing the equilibrium of the circulation. If this theory be adopted, digitalis is a sedative of the circulation, inasmuch as it calms its irregular action; but, if it really possess this power, it is by an exciting and tonic action. 2. The influence of digitalis on the temperature, the secretions, nutrition, the uterine contraction, hæmorrhages, &c., can only be explained by its exciting action on the ultimate filaments of the great sympathetic. This theory explains and justifies the favourable results obtained by the employment of digitalis in fevers, cerebral affections, hæmorrhages, and dysmenorrhœa, as well as in congestions, dropsies, and the circulatory affections, accompanying cardiac lesions.—Vide *Gazette Médicale de Paris*, April 27.

The Study of Human Histology is greatly facilitated, according to the recent statements of Herren Kölliker, and Cohnheim, by employing chloride of gold to stain the tissues. This substance appears to have a very peculiar effect on the histological elements. Tissues which have been soaked for some time in a weak solution of it, and afterwards exposed to light, are found to exhibit certain parts, ex gr. nerve-fibres, connective-tissue corpuscles and cells in general, stained of a bluish, violet, or reddish colour, while other parts, ex gr. intercellular substance, &c., are untouched. The fresh tissue should be covered with a little of a solution of from 1 to .2 per cent. of chloride of gold in distilled water (the strength must be made to vary according to the thickness of the object and other circumstances), and allowed to stand until it assumes a straw-yellow colour. It should then be washed and placed in very dilute acetic acid (1 to .2 per cent.). The colour will in the course of

some hours gradually develop itself. Nerve-fibres and connective-tissue corpuscles are exceedingly well shown by this method, which will probably come into very general use as a sort of correlative of the "silvering" method with dilute solutions of nitrate of silver. As a general rule, what the silver stains the gold does not, and *vice versa*.—Vide *Journal of Anatomy and Physiology*.

Development of striped Muscular Fibre.—Herr Eckhard has published a paper in *Henle und Pfeuffer's Zeitschrift*, in which he points out, as Huxley and others have done before him, that this species of muscular fibre is not developed from cells, but from a blastema. This blastema is nucleated, but the nuclei takes no share in the produce by which the internuclear matter is converted into fibre. Eckhard has also made observations on development of the heart of the chick, and states that at no period can cells be seen, but here, as in the muscles of the skeleton, the earliest stage is a nucleated blastema which rhythmically contracts before fibres make their appearance, the latter are developed from the internuclear matter directly. Lockhart Clarke had previously pointed out the fact that the development of the cardiac muscular fibre is the same as that of the voluntary muscles.

What is Hippuric Acid?—An abstract of the Researches of Shepard and Meissner, appeared in the *Centralblatt*, and has been again abstracted in the last number of our well-edited contemporary, the *Journal of Anatomy*. The inquiries of these *savants* throw much valuable light on the above question. However, Shepard and Meissner having entirely failed to find hippuric acid in the blood of herbivora, conclude that it is formed in the kidneys. This conclusion is supported by previous experiments of Meissner, who could find no hippuric acid in the blood even after the kidneys had been extirpated. After introducing benzoate of soda into the stomachs of dogs, they found benzoic acid in the blood and saliva, and succinic acid in the sweat; but hippuric acid could only be found in the urine. In opposition to Kühne and Hallwachs, they assert that they have satisfactorily proved that the conversion of benzoic into hippuric acid takes place quite independent of the liver. After ejecting hippuric acid into the stomach of rabbits, they found extremely little hippuric acid in the blood, though abundance was found in the urine; on the other hand, benzoic acid and urea were abundantly found in the blood. When, on the other hand, hippuric acid was injected subcutaneously, hippuric acid was found in the blood in large quantities, but no benzoic acid. Hence it appears that hippuric acid is decomposed in the digestive tract into benzoic acid and glycocholl, the latter of which, according to Küthe and Horsford, is easily transformed into urea. Meissner and Shepard have found in the cuticle of plants a substance having the following formula $C_{14}H_{12}O_{10}$, which is nearly identical with the formula for cinchonic acid $C_{14}H_{12}O_{12}$. From this substance they suppose the hippuric acid found in the urine of the herbivora to be derived.

Civiale's Collection of Calculi.—Shortly before his death, M. Civiale presented his splendid collection of calculi to the French Academy. At the same time he offered some important remarks upon the various forms, physical and chemical, of calculi.—Vide *Comptes Rendus*, May 13.

A useful form of Poultice, the invention of M. Genevoix, is now on view at the Paris Exhibition. It consists of an impermeable tissue, enclosing

a double layer of swanskin, which is wetted with a decoction of marsh-mallow, linseed, or poppy heads, and which maintains a temperature of 70° centigrade for more than twelve hours.

Termination of the Nerves in Muscle.—The views expressed by Dr. Lionel Beale in the several admirable memoirs he has published on this subject continue to be confirmed by their author's further researches. In the last number of his *Archives of Medicine*, Dr. Beale gives some very beautiful drawings of the plexuses of dark-bordered fibres, and those who desire to see the relations of ultimate nerve-fibre to ultimate muscle-fibre can do no better than consult these drawings.

The cause of Muscular Contraction.—The numerous and convincing experiments of Dr. C. B. Radcliffe, have already converted most of our modern physiologists to the doctrine that muscular contraction is nothing more than electrical discharge. While the muscles are at rest, the electric charge causes a condition of repulsion among the muscular elements by virtue of which the muscle is increased in length. The instant this electricity is discharged the repulsion ceases, and the natural attraction of the muscular particles coming into play, the muscle shortens. That such a discharge accompanies the muscular contraction is now one of the admitted facts of physiological science. The state of things in *Rigor mortis*, where there is the most complete degree of discharge, is a very powerful argument in favour of Dr. Radcliffe's views, but an appeal to the ordinary phenomena of nervous pathology puts the discharge theory of muscular contraction beyond all question. We call attention to these circumstances, because we notice in the last number of Dr. Beale's *Archives*, a paper by Mr. Baxter, on muscular contraction, in which the author makes a wholesale appropriation of Dr. Radcliffe's theory, but carefully avoids allusion either to Dr. Radcliffe's treatise, or to his papers read before the Royal Society. Perhaps Mr. Baxter is unfamiliar with Dr. Radcliffe's researches. If such be the case, the sooner he informs himself upon them, the better.

: METALLURGY, MINERALOGY, AND MINING.

Iridium in Canada.—In one of the Canadian journals, it is stated that a Mr. Meves of Madoc, has found iridium among the materials which exist with gold in the Richardson mine. This is not in accordance with the report of Dr. Sterry Hunt, and Mr. Michel; but as Mr. Meves' specimens were derived from a different portion of the vein, it is possible that the existence of iridium may be a fact. Iridium is a hard metal, and exists in the Californian gold; its presence in the gold coined at the United States' mint caused the destruction of several valuable dies, and thus led to its discovery.

A New Fuel.—This is a modified peat-fuel for which Mr. Lee has taken out a patent. It is said to possess many advantages over coal, as regards economy and production of steam-power. The *Shipping Gazette* gives the following account of some experiments lately made with this fuel:—"The results arrived at were considered to prove that peat, when properly dried

and submitted to a certain process, and then saturated in oil, has greater heating power than the best Welsh coal. The advantages possessed by this peat fuel are the rapidity with which a fire can be lighted, and economy in working and space. Put a few blocks in the furnace, apply a match, and in an instant the whole is in a mass of flame. Very little stoking is required."

Electro-Magnetism in Iron Smelting.—An experiment has been tried at Sheffield to test the action of electro-magnetism, on the smelting of iron, and if we are to believe reports the results were highly satisfactory. The following account is given of the experiment:—A fixed electro-magnet is placed opposite an opening in the side of the furnace: the magnet is excited by means of a Smee's battery, and the current of magnetism is directed into the molten metal. The effect is described as being surprising. The metal appears to bubble and boil; and the quality of the iron is so much improved that for toughness and hardness it can hardly be equalled.

Gun-cotton in Mining.—It is stated that by combining ammonia with gun-cotton, its liability to spontaneous combustion is removed without injuring its explosive qualities.

Pozzolana.—A late number of the *Mining Journal* contains a letter from Naples announcing the discovery of a valuable deposit of this cement. It has been found at the foot of Vesuvius, on a property called *Torre Bassano*. The strength of this cement is said to be equal to, if not greater than that of the celebrated pozzolana of S. Paolo, of Rome, whence England has generally drawn her supplies. In 1852 there was a "find" of the same material, and the Government of that day were so satisfied as to its merits that they used it in the construction of the only dry dock in Naples. On making some alterations in this dock recently it was with the greatest difficulty that any impression could be made on the pozzolana above mentioned, proof being thus given of its great excellence. The Government has already contracted for a considerable quantity of it for the construction of the new mole, and for other public works in Palermo, and much has been exported to Alexandria.

Bismuth in Australia.—We learn from the *Melbourne Age* that a discovery has recently been made in South Australia of a lode of bismuth, samples of the metal being now to be seen at the Melbourne Exchange, to which place it has been sent from the neighbouring colony. This metal is very valuable if found in quantity, and it is stated that the lode discovered contains abundance of rich "stuff," but being situated about 200 miles in the interior, some serious difficulties in the cost of carriage have been encountered. Trouble was also experienced in getting the metal smelted, but a quantity of it was sent to England in ingots some time since, and it is expected the supply will be kept up.

A Rotary Blower, deserving the attention of all who are engaged in "blast" operations, is now exhibited in the French *Exposition*. It is the invention of Messrs. Roots of Connersville, Indiana, and is, we believe, extensively used in America. It is an improvement upon the ordinary system of "cylinders," and has not the drawbacks either of the cylinder or the fan. It requires less than half the power to run it of even a fan; its speed is not excessive, being only from 200 to 300 revolutions per minute, whilst the ordinary speed of a fan is ten times greater; and at the same time it can

force air at any pressure whatever, if sufficient steam power be used, without any of the friction and loss of power incidental to a blowing cylinder. The principle is that of two irregularly-shaped blowers revolving in an oval cylinder. These blowers are so arranged that as they revolve, the air which enters is pent up between them, and driven with any required force through the escape-hole.

Japanese Alloys, their Nature and Nomenclature.—The Builder gives the following abstract of a paper which appeared some time since in an American scientific journal:—The first alloy given may be regarded as a weak Japanese imitation of jewellers' gold. This *Shakdo* is an interesting alloy of copper and gold, the latter metal in proportions varying between 1 per cent. and 10 per cent. Objects made from this composition, after being polished are boiled in a solution of sulphate of copper, alum, and verdigris, by which they receive a beautiful bluish-black colour. '*Gin shi bu ichi*,' ('quarter silver') is an alloy of copper and silver, in which the amount of silver varies between 30 per cent. and 50 per cent. Ornamental objects made from this composition take, when subjected to the action of the above solution, a rich grey colour, much liked by the Japanese. *Mokume* is a mixture of several alloys and metals of different colours associated in such manner as to produce an ornamental effect. Beautiful damask work is produced by soldering together, one over the other in alternate order, thirty or forty sheets of gold, *shakdo* silver, rose copper, and *gin shi bu ichi*, and then cutting deep into the thick plate thus formed with conical reamers, to produce concentric circles, and making troughs of triangular section to produce parallel, straight, or contorted lines. The plate is then hammered out until the holes disappear, manufactured into the desired shape, scoured with ashes, polished, and boiled in the solution already mentioned. The boiling brings out the colours of the *shakdo*, *gin shi bu ichi*, and rose copper. Of brasses (*Sin chu*) the finest quality of brass is formed of 10 parts of copper and 5 parts of zinc. A lower quality, of 10 parts copper and 27 parts zinc. *Kara kane* (bell metal) varies from first quality—copper 10, tin 4, iron $\frac{1}{4}$, zinc $1\frac{1}{2}$, to fourth quality—copper 10, tin 2, lead 2. The best small bells are made from the former quality, and large bells from the latter.

Iridium from Blende.—Herr Boettger has pointed out that the flue-dust which condenses in the chimneys of the zinc works of Goster contains oxide iridium in the proportion $\frac{1}{10}$ th per cent. He gives the following directions for its extraction. Boil the deposit for half an hour with hydrochloric acid, and digest the clear liquid with pieces of zinc for six hours at the ordinary temperature. There is then deposited a black metallic powder, which is washed with water, and which contains copper, arsenic, cadmium, thallium, and iridium. By boiling this with a concentrated solution of oxalic acid, a solution of cadmium, thallium, and iridium is obtained; the latter is precipitated by ammonia, and the precipitate is then boiled with ammonia and afterwards with water, until the washings contain no more thallium. The oxide of iridium is then almost pure, and only contains traces of iron.—Vide *Journal für praktische Chemie*.

Motive Power in Mines.—M. Tresca made a recent communication on this point to the Society of Encouragement. Works in mines require a motive power, either sudden and discontinued or continuous and slow. In the first

case, the best motor is compressed air ; in the second, water under pressure. As in tunnel work there can be no admission of fire, combustion, or the engendering of steam. Compressed air has been happily employed by M. Sommelier for the engines used by him in the tunnel of the Alps. Water under pressure was employed by M. Perret in the works of the South of France railways, to give a rotatory movement to the rings or circles of M. Deschaux, armed with diamond points for cutting the hardest rocks.—*Vide Foreign Correspondence, Chemical News.*

The Chatham Ballast-iron.—The Admiralty having at last perceived the value of the ballast-iron and having determined on its sale, orders for several thousands tons of this material have been already sent in. The examination of the ballast-iron in use at Chatham dock-yard showed that there are four or five different qualities, the best kind being very valuable. The quality of the iron, however, can only be ascertained after each pig has been split asunder, to allow of the crystals being seen ; and as the method in which the iron is broken has been found to materially affect its quality, the duty of breaking each of the pigs of the quantity of iron sold will be undertaken by Messrs. Ryland, who will be paid at the rate of 1s. 6d. per ton for this work, in addition to their commission on the sales. The Admiralty order also directs the sale of 2,000 tons of the ballast-iron in store at Sheerness Dockyard, on the same conditions. The circumstance of the iron requiring to be broken before it is sold will render the entire 4,000 tons useless as ballast-iron, should the Admiralty terms not be accepted. It is worthy of remark that, notwithstanding the comparatively high value of the ballast-iron, the experience of the last few years has completely proved that in a dockyard like Chatham, in which the traffic of enormous armour-plates, with the heavy slabs, plates, and iron beams used in the construction of iron ships is going on all at hours of the day, the granite tramways laid down require renewing and repairing at intervals of a few months ; while, on the other hand, the passage of the heavy weights has no perceptible effect upon those portions of the yard where the tramways are laid with pigs of iron.—*Vide The Artizan, June.*

MICROSCOPY.

Under this section we have little to record for the past quarter. Mr. Stokes has written to the *Microscopical Journal* on the subject of "slides by post," and as the matter is of interest we shall give a short account of the method he proposes to avoid breakage of slides when travelling through the post office. He says, cut two narrow slips of card-board, and gum them across the slide on each side of the cover, so as to prevent a slide or the side of the box from touching the cover ; roll up four or five slides in paper, and place them in one of the ordinary postal boxes. The box should be left bare and an ordinary parchment label attached to it, by lacing a cord round it. On this label the direction should be written and the stamp affixed.

New Objects for the Microscope.—Mr. Dancer has read a paper before the Manchester Philosophical Society, in which he says that the coal ash from

the flue of a furnace supplies some interesting objects for the Microscope. Besides other bodies contained in this coal ash may be seen a number of curious-looking objects which vary in size and colour. The majority of these bodies are spherical, and when separated from the irregularly shaped particles forming the bulk of the dust they become interesting objects for the microscope. Some of these are as perfect in form as the most carefully turned billiard balls, and have a brilliant polish. The various colours which these globules exhibit give additional interest to their examination. Some are transparent crystal spheres, others are opaque white, many are yellow and brown, and variegated like polished agates or cornelian of different shades. The most abundant of the highly polished balls are black; there are others which look like rusty cannon balls—some of these have an aperture in them like a bombshell, and many are perforated in all directions. To obtain these objects the dust should be washed in a bowl and all the lightest particles allowed to float away; the remainder consists of fragmentary crystalline and ferruginous substances; mixed with these are the polished balls described, which, under the microscope, by a brilliant reflected light, look like little gems. To separate the spherical bodies from the irregular ones, it is only necessary to sprinkle some of this material on an inclined glass plate, and by gentle vibration the balls roll down, and can thus be collected.—Vide *Chemical News*, June 21st.

PHOTOGRAPHY.

Photography at the Paris Exhibition.—On the whole, the art-science of photography plays its part well at the great French International Exhibition, and in the collective displays of various nations we find its numerous and diverse applications, improvements, and modifications fairly represented. The Austrian collection is a very attractive one and contains some of the very best specimens of photo-lithography yet produced; its specimens of portraiture from life-size downward are of a very excellent character, and, like those of France, Prussia, and Russia, are decidedly superior to the English. In the Darmstadt contributions are some interesting specimens by Dr. Reissiz exhibited to illustrate his theory of photogenic action. In the Prussian department a large portrait lens attracts attention; it is fourteen inches in diameter and covers a square of thirty inches. The French department contains some interesting specimens of photographic-engraving process, of enamelled photographs, and of enlargements from microscopical photographs, amongst which is one of a flea enlarged to the size of a small pig. Amongst the novelties and applications of photography to decorative art are photographs of a singular character, illustrative of a new process called "Chrysoplasty." They represent goldsmiths' work, ancient armour, draperies embroidered with gold and silver, bronze statuary, philosophic instruments, &c., and are apparently in the same metals as the originals. This process is a secret one, but the inventor, Mr. Boeringer, is prepared to produce such photographs from any negatives which may be sent him for that purpose. He is at present making a large collection of specimens from antique curi-

osities and works of art in metal dispersed in the public and private museums of various nations, and with this end in view appeals to the owners and guardians of such collections, and those who have negatives of the required description, to render him assistance. In photographic portraiture, by universal consent, the French stand prominently foremost, so much so that as the *Times* says "amongst those articles which are specially called *articles de Paris*, a good photographic portrait is now to be placed." In the English department we miss most of our foremost photographers, amongst them Mr. O. G. Reglandes, Mr. T. R. Williams, and but too many others. Mr. Mayall, M. Claudet, Lock and Whitfield, Ross and other of our chief portraitists exhibit largely, but all show but weak and mean when contrasted with their rival portraitists as represented in the French collection. As landscapists English photographers, like English painters, carry off the palm. Why landscapes by English operators so far surpass others we cannot explain, but no one with any artistic taste or judgment, would hesitate to attribute the superiority of the French portraits purely and simply to a more refined taste and greater knowledge of pictorial science in their producers. The English photographs display little merit beyond such as belongs exclusively to the skilful management of good tools, while the French photographers are evidently, as a rule, artists studying such things as lighting, posing and arranging, exposing and developing with considerable artistic knowledge and preconceived design, the former with a view to putting a picture before the lens, and the latter with a view to its faithful reproduction in the operating room. Two of the great secrets of their greater success will, we believe, be found to reside in the much longer exposures they give their plates in the camera and in the use of a developer not so rapid in its action as to escape control during development. The great cry in England has been for short exposures and powerful developers, things which war against the subtle delicacies of gradations from light to dark, and from darks into reflected lights, which constitute one of the most special and striking peculiarities of the best French portraits. Refer back to past volumes of the English photographic journals and this craving for extraordinary rapidity coupled with frequent mention of the extraordinary long exposures given on the continent, where the light is more powerful and the atmosphere more pure, will be found. You will also perceive that while articles tending directly and indirectly to give mechanical manipulation and good tools all the credit of increased success crowd their pages to a wearying degree of sameness and repetition, papers of a truly art-educational character are extremely rare, in consequence, we have been informed, of the little real appreciation they meet with from English photographic students. Hence probably the inartistic and tasteless character displayed by their photographs when contrasted with those of our more artistic and tasteful neighbours.

The Duc de Luynes Prize.—In 1859 the French Photographic Society distributed the sum of 2,000 francs as prizes for the best researches in producing unalterable photographs, and as part of the sum of 10,000 francs devoted to that purpose by the Duc de Luynes. The society then fixed upon the 1st of April, 1864, for the further award of the remaining sum. The decision of the jury was however postponed and the decision announced on the 5th of last April awarded the 8,000 francs to M. Poitevin for his photo-lithographic process published in 1855. According to this decision all the claims made

by M. Poitevin's rival competitors, Talbot, Niece de St. Victor, Lemer cier, Charles Negre, Placet, Woodbury, Pouncy, Paul Pretsch, Cole, James, and others, have achieved nothing, having greater pretensions to permanency than a process extant in 1859 had. And yet good and truly permanent photographs are almost as much a want of the age now as they have been since the art's discovery, and all our best experimentalists are still hard at work in this identical direction.

Preservation of Photographs.—In a paper read before the Glasgow Photographic Association on the 11th of April, Mr. J. Stuart recommended the saturation of prints with collodion as a means of ensuring their permanency. Since then others have strongly recommended this process as a very valuable one, well calculated to effect the desired end, and Mr. Valentine Blanchard in a paper read before the London Photographic Society, gave the result of some experiments in carrying out Mr. Stuart's idea. On this occasion the Rev. J. B. Reade, F.R.S., who occupied the chair, gave the entire credit of the idea to Mr. Blanchard as others have done since, and said the process really conferred immunity from fading. Mr. Belton, at the June meeting of the North London Photographic Association, stated that it was best according to his experience to apply the collodion to the prints somewhat sparingly, both before and behind, with a brush, and to immerse them in hot water before mounting, so as to render them more plastic. He had used starch for mounting, but thought good glue would prove the better material.

The Collodio-Albumen Process.—Mr. Maxwell Lyte, whose excellent photographs have been so often and widely admired, and from whom we have so frequently derived hints of great practical value, has introduced a modification of the collodio-albumen process, by which it is said to be rendered more sensitive. The iodides and bromides he employs are those of sodium, and he does not advise the use of salts of cadmium. After sensitising, the plates are washed and rewashed in a weak solution of salt to remove the free nitrate of silver. The albumen is prepared by an ammoniacal solution of chloride of silver, and the plate allowed to dry over a capsule of sulphuric acid, in order to absorb all the free ammonia. The developer is a solution of protosulphate of iron without acid. The albumen used should not be thick, and all the ammonia should have evaporated before exposure.

Photographs in Colours.—M. Poitevin's photographs in natural colours, described in these pages, were recently stated by that gentleman to fade even in the dark.

Oxalic Acid in the Negative Bath.—An editorial article in the "British Journal of Photography," speaks of the presence of pin-holes in the film and insensitive streaks on its surface as frequently due to the presence of crystals consisting of oxalate of silver. After explaining how oxalic acid may be present in the collodion, the article attributes thereto the formation of the above crystals, and says their nature may be readily proved by two very simple tests. One is to heat over a spirit-lamp a few of the crystals previously washed in a little water and then dried in a small tube closed at one end, when if oxalate of silver they will detonate almost like a few grains of gunpowder, and the other is the placing of a few of the crystals in powder on a watch glass, adding a little water with a drop of sulphide of ammonium.

If then stirred, and allowed to stand for an hour or so the black sulphide of silver will be produced, and oxalate of ammonium contained in the liquid. The latter is then filtered off into a test tube and boiled with the addition of a drop or two of dilute acetic acid, and solution of sulphate of lime added when the production of a white precipitate insoluble in acetic but easily dissolved in nitric acid. This at once indicates the presence of oxalic acid. The writer then gives as the best remedy with which he is acquainted, the adding of a drop or two of solution of nitrate of lime to the bath, when the precipitate can be removed by filtration. Any slight excess of the nitrate of lime will not injure the bath.

The Bromized Collodion Process.—This process of Major Russell's is described by the editor of *Photographic Notes*, as "the first in point of absolute merit" of all the "dry collodion processes;" and he continues, "Nothing can surpass the beauty of its specimens produced by the Major himself. We have never seen foliage in all its depths so admirably rendered as in some of these specimens;" and moreover adds, that they are "the most sensitive plates ever exposed in a camera up to the present time." Knowing these to be the opinions of a good practical and scientific photographer we give our readers the process, which is briefly this:—"The collodion contains about 8 grns. of bromide of cadmium to the oz. and no iodide. The plates are immersed for ten minutes to a quarter of an hour in a 70 grn. nitrate bath, acidified with nitric acid, and they are then washed *excessively*." This is a point of primary importance. The washed plate is then coated with tannin, or some other suitable organic matter, and is allowed to dry spontaneously. The exposure is the same as in the wet process, and the development is effected by means of a solution of pyrogallie acid, to which carbonate of ammonia is added. No subsequent intensification is necessary, because any degree of density can be obtained by increasing the proportion of carbonate of ammonia added to the solution. To retard the action of the developer, which would otherwise be too energetic, add bromide of cadmium, which must be very nicely proportioned to the quantity of alkali, a slight excess tending to enfeeble the image and too little to produce fog. The exact balance can only be hit by frequent experiment, and when attained, care should be taken always to preserve it. With this additional care the process is one of exceeding value both as regards the artistic value of its result and scientific accuracy of principle. We must add that the plates do not keep so long after exposure as others do.

The Photographic Society.—The *Photographic Times* commenting on the present unpromising position and gloomy prospects of the London Photographic Society says, "Only fancy an association having less than 300 members, and an income of as many pounds (if every member pays), paying its secretary £150 per annum. This sum will seem the more inordinate when it is considered that the society holds but eight meetings per annum, and when it is considered that many competent men would be glad to hold the post as an honorary, appointed for the mere love of an art which *they* practise as a scientific recreation.

Photography in London.—The official catalogue of the Paris Exhibition, British department, gives the following statistical account of the number of persons engaged in photographic trade in London, exclusively of workmen.

Photographic artists, 284; apparatus makers, 38; album makers, 38; chemists, 17; mounters, 6; paper makers, 15; publishers, 16; dealers in materials, 28.

New Photo-Engraving Process.—The *Chemical News* asserts that a new process of photo-engraving by M. Baldus is about to be introduced, far surpassing in simplicity, certainty, and beauty of result, the best works produced by Messrs. Woodbury, Swan, and others, and at a price fabulously low. The process is a secret one but is said to be exceedingly simple.

Long-kept Plates.—At a meeting of the Philadelphia Photographic Society a member exhibited a print from a tannin negative which had been kept *five years* previous to exposure, and a tannin negative developed *one year* after exposure.

The Nature of the Latent Image.—Mr. Carey Lea has advanced what he considers "some entirely new views," on the nature of the latent image: he says: "When light considered in reference to its illuminating power falls upon any surface, we are accustomed to regard the effect of that illumination as passing away at the same instant of time that the illumination terminates. But there are a vast number of well recognised exceptions to this rule which we know under the name of phosphorescence and fluorescence," which proves, says Mr. Lea, "that bodies may by light be thrown into a state of vibratory motion, lasting for a longer or shorter, sometimes for a very considerable time after the exciting cause is removed, and that, so long as this vibratory movement continues they will themselves emit light." The writer then proceeds to argue that there is no reason to doubt the property we conveniently call actinism may have similar power on certain bodies and that the latent image "is simply a phosphorescence of actinic rays. . . . Pure iodide of silver undergoes no decomposition by light when thoroughly isolated from all substances, organic and inorganic, which are capable of aiding in effecting a reduction. But, if exposed to light, it continues for a certain time thereafter to retain the vibrations it received; and just for so long as these vibrations continue will it be instantly decomposed if brought into contact with any substance which would have caused its decomposition had the two been subjected to the action of light together. . . . For this property of light I propose the name of 'ACTINESCENCE.' The more we examine these phenomena the more we shall perceive that actinescence must, so to speak, exist; for different phosphorescent bodies emit light of very different colours, showing that their respective capacities of prolonged impression are confined to rays of a certain refrangibility, differing from each other in each case. Now we know that the actinic influence accompanies rays of a certain refrangibility, especially the violet, the indigo, and the rays immediately beyond the visible. The permanence therefore of these actinic rays, under suitable circumstances is no more difficult of conception than that of other rays, a fact which has been known and recognised for centuries." Mr. Lea then argues that the faculty of receiving a latent developable impression depends on the possession of two properties, viz. sensitiveness to light, and actinescence; that a body may be actinescent without being sensitive to light, and therefore unable to retain the latent image, and that on the other hand substances may be merely sensitive to light when brought in contact with others, but which not retaining the impressions made by light until the decomposing agent be

brought in contact with them, are likewise incapable of receiving latent images. But these capacities may exist conjointly, as we see in the case of large numbers of silver compounds. This new theory rests upon these facts, namely, the sensibility to light of pure iodide of silver and the spontaneous reensensitising of pure iodide of silver, and will, as Mr. Carey Lea believes, "dispel all the mystery that has seemed to some to envelope the idea of a physical image and bring all the most obscure facts of photo-chemistry into parallelism with well understood and very simple phenomena." We quote from the *British Journal of Photography*, in which, unless we are much mistaken, similar views were put forth some time since.*

A *New Camera* has been introduced in America for producing simultaneously any number of portraits of a sitter with one lens. This is obtained by the adjustment of a number of movable mirrors fastened on blocks of wood and so contrived as to throw the reflected images each on the proper part of the plate or focussing screen.

PHYSICS.

The Physics of Chemical Reaction.—According to the researches of M. Berthelot, a chemical reaction, which is capable of setting free an appreciable quantity of heat, will always accompany the following conditions:—1. The reaction is one which reaches its limit within a very short time from its commencement; this condition is fundamental. 2. The reaction is one which begins without foreign aid at the temperature of the commencement of the experiment; reactions excluded by this condition act in conformity with the principle enunciated if they are caused to set in either by raising the temperature or by other means. 3. The parent substances and the products possess similar functions. He is of opinion that the inverse reactions of iodhydric acid and argentic chloride might be foreseen from the basis of this general principle, and that the analogous action of iodhydric acid on potassic chloride, which he has experimentally verified, is a further proof of the correctness of his view.—*Vide Chemical News.*

A "*Standard*" Spectrum, which promises to be exceedingly useful, and

* Since the above was written, Mr. W. H. Harrison has written to the paper in which Mr. Lea's articles appear, expressing "unbounded astonishment" to find that gentleman republishing his ideas as new ones of his own, without any alteration whatever, except a guess, unsupported by experiment, "that the moving molecules vibrate with a motion which throws off chemical rays." Both Mr. Lea and Mr. Harrison have long been constant contributors to the *British Journal of Photography*, in which the papers on "The Mechanical Action of Light," to which the latter gentleman alludes, were published not longer ago than last autumn. Our own impression is that these ideas were published long before either Mr. Lea or Mr. Harrison advanced them in Hunt's "Researches," but between this and our next issue we shall give the matter further attention.

seems likely to be conducive to discovery in this department of physics, has been devised by Mr. H. C. Sorby. Mr. Sorby proposes that it shall be used as a scale in all descriptions of spectra as seen by the micro-spectroscope. The following is Mr. Sorby's description of the new scale. It is an interference spectrum, produced by a plate of quartz $\cdot 043$ inch thick, cut parallel to the principal axis of the crystal, and placed between two Nicol's prisms. In this the whole visible space is divided by dark bands into twelve regular divisions, having in all parts the same relation to the physical properties of the light. These are counted from the red end towards the blue, their centres being reckoned as 1, 2, 3, &c. and the thickness of the plate is so adjusted that the sodium line exactly corresponds to $3\frac{1}{2}$. The intensity of the absorption is expressed by the following types:—

Not at all shaded		Blank space
Very slightly shaded	. . .	Dots with wide spaces
Decidedly shaded	...	Dots closer together
More shaded	...	Very close dots
Strongly shaded, but so that a trace of colour is still seen	} ---	Three hyphens close
Still darker	—	Single dash
Nearly black	——	Double dash

Except when specially requisite, only the symbols . . . --- — are employed for the sake of simplicity, and then as signs of the relative rather than of the absolute amount of absorption, and it is assumed that there is a gradual shading off from one tint to the other, unless the contrary is expressed.—*Chemical News*, May 3.

The Contractions and Dilatations of Iodide of Silver.—At a meeting of the French Academy on April 15, M. Fizeau returned to this subject. He found that with iodide of silver, whether in its amorphous or crystalline state, the action of heat established by him is reversed; its dilatation is negative, contracting instead of expanding on the increase of temperature. But this negative dilatation is not quite the same in the amorphous state, in the state of compressed precipitate, as in the crystalline state; —0·00000137 in the first case, —0·00000139 in the second.

The Determination of the Density of Ozone.—A note on this subject was communicated to the Academy of Science by Mr. Soret, of Geneva. Experiments by means of absorption lead to the conclusion that the density of ozone is one and a half times that of oxygen. He applied Graham's law of diffusion—viz. that the diffusion takes place in the inverse proportion of the square of the density. He then diffused two mixtures—one of oxygen and chlorine; the other of oxygen and ozone. Thus compared, the density of ozone to that of chlorine or oxygen was found to be 1 : 5.

Development of Ozone during the present year.—A correspondent of the *Chemical News* gives an account of the development of ozone since the first of January. In January there were two well-marked periods of scarcely a trace of ozone—namely, from the 1st to the 5th, culminating on the 4th, when the test was colourless, and from the 10th to the 19th, culminating on the 13th, 14th, and 18th. Both these periods were followed by

equally well-marked periods of a large development of ozone. In February no such well-marked and settled periods occurred. On some days there was but little ozone, as, for instance, on the 2nd, and the afternoons of the 21st and 28th, especially on the afternoon of the 21st; while on other days there was a good deal, as on the 16th, 18th, and 20th. But the periods of increased and decreased development were short and unsettled, often lasting not more than a few hours, and at most a day or two. In March there was scarcely a trace of ozone on the 1st and 2nd, and very little on the 3rd, 8th, 9th, and 16th; considerable quantities on the 13th, 25th, 27th, and 30th, especially on the 25th and 30th. Speaking generally, there was a period of scanty development of ozone till the middle of the month, and then a period of more plentiful development towards the end; but neither of these periods was well defined or settled.—Vide *Chemical News*, April 19.

The Measurement of the Magnetic Dip.—A paper was lately read before the *Manchester Philosophical Society* by Sir William Thomson, on a new form of the dynamic method for measuring the magnetic dip. Seven years ago, an apparatus was constructed for the natural philosophy class of the University of Glasgow, for illustrating the induction of electric currents by the motion of a conductor across the lines of terrestrial magnetic force. This instrument consisted of a large circular coil of many turns of fine copper wire, made to rotate by wheelwork about an axis, which can be set to positions inclined at all angles to the vertical. A fixed circle, parallel to the plane containing these positions, measured the angles between them. The ends of the coil were connected with fixed electrodes, so adjusted as to reverse the connections every time the plane of the coil passed through the position perpendicular to that plane. When in use, the instrument should be set as nearly as may be in the magnetic meridian. The fixed electrodes being joined to the two ends of a coil of a delicate galvanometer, a large deflection is observed when the axis of rotation forms any considerable angle with the line of magnetic dip. On first trying the instrument, Sir William perceived that its sensibility was such as to promise an extremely sensitive means for measuring the dip. Accordingly, soon after he had a small and more portable instrument constructed for this special purpose; but up to this time he had not given it any sufficient trial. On the occasion of a recent visit, Dr. Joule assisted at some experiments with this instrument. The results have convinced both observers that it will be quite practicable to improve it so that it may serve for a determination of the dip within a minute of angle.

The Movement of Solids under Pressure.—M. Tresca, whose fine researches we have before noticed in these pages, has presented a second part of his memoirs to the Academy. This portion of his memoirs relates to the flowing of solids through simple or multiple circular, polygonal, and lateral orifices, and described a great number of interesting particulars which confirm the results of his former experiments, and undoubtedly prove that the molecules of substances of the stiffest nature in appearance possess the property of moving independently, generally in parallel directions. The flowing takes place in concentric zones.—Vide *Comptes Rendus*, April 22.

The Periodical Variations of Temperature.—M. St. Claire Deville has been publishing a second series of his investigations in the above interesting meteorological subject. He has established, in one of his former memoirs,

that there exists a certain depending connection in the movement of the mean temperature of four days, placed on the ecliptic at an angle of 90° one from the other, for the four months (opposed two by two) of February, May, August, and November, which contain the critical days, known by the ancients under the name of the *three saints of ice* (May 11, 12, 13), and the *summer of Saint Martin* (November 11). In this new work he shows that the fact is general, and that this connection or mutual dependence of the four opposite days exists during the whole of the year; whether we take into consideration a considerable cycle—110 years at Berlin, 90 years at Vienna, 50 at London, 40 at Prague and Edinburgh, 30 at Brussels, 24 at Toulouse, 21 at Paris—or that we take in this point of view an isolated year (1864) on several European stations. The former, depending upon the same data, establishes, in fine, that this connection is evident also when we combine twelve by twelve the days separated one from the other by 30° of the ecliptic. The latter phenomenon constitutes the *meteorological month*, as the *season* was established by the consideration of the quadruple days.

Alteration of the Freezing-point in Thermometers.—Dr. J. P. Fowler, F.R.S., has recorded an important fact in connection with the alteration of the freezing-point in thermometers which have been for some time in use. Having had in his possession, and in frequent use, for nearly a quarter of a century, two thermometers, of which he has from time to time taken the freezing-points, he thinks the results of some interest. Both thermometers are graduated on the stem, and are, he believes, the first in this country which were accurately calibrated. Thirteen divisions of one of them correspond to one degree Fahrenheit. It was made by Mr. Dancer in the winter of 1843–44. His first observation of its freezing-point was made in April 1844. Calling this zero, his successive observations have given

0	April 1844.
5.5	February 1846.
6.6	January 1848.
6.9	April 1848.
8.8	February 1853.
9.5	April 1856.
11.1	December 1860.
11.8	March 1867.

The total rise has been, therefore, .91 of a degree Fahrenheit. The other thermometer is not so sensitive, having less than four divisions to the degree. The total rise of its freezing-point has been only .6 of a degree; but this is probably owing to the time which elapsed between its construction and the first observation being rather greater than in the case of the other thermometer. The rise of the two thermometers has been almost identical during the last nineteen years.

Crystalline Refraction.—M. A. Cornu has written a memoir on this subject, in which he propounds a new theory of Fresnel's law of crystalline refraction. The principal conclusions of the report in his memoir were, that the luminous vibrations were normal to the plane of polarisation, as Fresnel and Cauchy announced a long time ago, though the direct proofs hitherto proposed are open to discussion.

How to Drill Glass.—An ingenious method of drilling glass, which was first described in *Hardwicke's Science Gossip* and quoted by the *Chemical News*, has elicited from Dr. Lunge an account of another means which he has found extremely simple and efficient. It is simply the employment of dilute sulphuric acid—and he found it, on trial, to answer much better than the method referred to. Not only, it appears, is the efficacy of the cutting tool more increased by sulphuric acid than by oil of turpentine, but also, strange as it seems, the tools (files, drills, &c.) are far less rapidly destroyed by being used with the acid than with the oil. He also found it stated that, in the engineering establishment of Mr. Pintus, at Berlin, glass castings for pump barrels, &c., were drilled, planed, and bored, just like iron ones, and in the same lathes and machines, by the aid of sulphuric acid. As to drilling, Dr. Lunge can fully testify to the efficacy of that method. Whenever he wants, say, a hole in the side of a bottle, he sends it, along with some dilute (1:5) sulphuric acid, to the blacksmith, who drills in it, with a hand-brace, a hole of $\frac{1}{4}$ -inch diameter. This hole is then widened to the required size by means of a triangular or round file, again wetted with the acid. He also finds a great help in the latter when making graduations on litre flasks, &c. There is hardly any smell perceptible during the work, which proves how little the acid acts upon the tools, undoubtedly owing to their being tempered; but each time after use, he takes the precaution to wash and dry the files at once, and he has so far observed no sensible deterioration in them.

Transparency of Metals at a bright Red Heat.—Dr. Adriani has written a letter to a contemporary relative to the reported discovery of Father Secchi, that metals at a red heat are transparent. He states that the fact that iron, steel, and also platinum and copper, are transparent while at a bright red heat, has been known long since not only to practical engineers, but, as regards iron, steel, copper, and platinum, to workers in these metals. The account given of the manner in which M. Secchi found out this property of iron is as follows:—The reverend Father had ordered a strong iron tube to be made. As it was intended for an apparatus requiring a vacuum, it was essential that this tube should be perfectly airtight: and as Father Secchi had some doubts about its soundness in this respect, in order to set these at rest, the tube was made red-hot and taken into a dark place, when he clearly perceived through the iron, which was half a centimètre thick, a crack inside the tube, and which did not reach to the outer surface. It is rather curious that the fact of the metals above alluded to (to which Dr. Adriani says he has reason to believe that gold may be added) becoming transparent at red heat should have escaped the notice of scientific men. It requires, however, a good bright red heat; but the transparency of the metals is, he says, evident thus even in daylight, as he knows from his own experience, while working many years ago in an engineering establishment attached to a large sugar refinery.

The Bisulphide of Carbon in Coal-gas.—The valuable researches which have just been published by Professor Alfred G. Anderson, demonstrate beyond all question the imperfection of the apparatus at present employed in the estimation of bisulphide of carbon in coal-gas. We cannot here enter into details of this chemist's enquiries, but we may state that they support two conclusions, which are thus stated by the author:—1. That in

determining the sulphur of coal-gas, the "single" (fish-tail) burner, caused to consume the gas at the rate of $2\frac{1}{2}$ cubic feet in five to six hours, effects its combustion most completely. That even under these circumstances 2 per cent. of its sulphur cannot be burned into sulphurous acid. 2. That in no case can the sulphurous products of the combustion be wholly recovered where condensing receivers open to the external atmosphere are employed. The best arrangement of apparatus set up on this principle loses 40 per cent. of sulphur. And the arrangement given by Dr. Letheby, I find, from the same cause, always entails a loss varying from *three-fourths to four-fifths* of the bisulphide sulphur of the gas.

Professor Anderson has already given evidence upon the subject of coal-gas before various Committees of the House of Commons, and we trust that, in the event of the passing of the new Act, the Government will select men of his practical experience for the proposed offices of Inspectors.

ZOOLOGY AND COMPARATIVE ANATOMY.

The Australian Timber-boring Insect, Tomiscus monographus.—The last-named species which is stated to be new to Australia, has, we believe, been recently introduced into that country. It is a most destructive creature, which seems to prey on casks and barrels with a voracity almost unequalled in the class to which it belongs. The *T. typographus*, a species more familiar to entomologists, is said to have destroyed no less than a million and a half of pines in the Hartz forest in the year 1783. An Australian paper gives the following description of this species, and of its ravages among the casks in some of the local breweries:—The proboscis forms an excellent gimlet, with which the little insect penetrates the hardest wood in an incredibly short time, while the hinder portion is shaped like a shovel, and is employed in getting rid of the sawdust. They make clean holes through the staves; and some of the full barrels are leaking in fifty places. In a wine-cellar, thousands burrow into the wine and spirit casks. As soon as they get nearly through the wood, the liquor begins to ooze out, and the animal, of course, gets killed. Every description of box or barrel is full of them, also the doors and timber in the building. Almost every store in the township is infested with these mischievous insects. The head is red, with a proboscis somewhat resembling a parrot's bill; and the body is like a small black glass bugle broken off at the end; the whole length, one quarter of an inch.

The silk-worm disease has this year shown itself at Grenoble, under a new form, and is doing extensive damage. According to the reports, the worm does not present any of the symptoms such as blackish spots, noticed in former years, but when it has arrived at the third change, it cannot go any further, and dies of exhaustion. This is attributed to the yellowish leaves of the mulberry, which do not furnish sufficient nourishment. The evil has not been so great in fact in the Ardèche or the Gard, where the weather has been less rainy. Too much rain, it is known, proves injurious to the nutritive qualities of the mulberry leaf.

The Crested Agouti.—Mr. St. George Mivart, of St. Mary's Hospital, has

reprinted his fine monograph upon the Crested Agouti. His investigation of the *Dasyprocta cristata* was conducted jointly with Dr. J. Murie, of the Zoological Society, and the facts arrived at may be thus briefly stated: (1) The unconstricted condition of the stomach of *D. cristata*, as compared with that of *D. aguti*; (2) the tendency towards a double apex of the heart; (3) the approximation of the ureters to the fundus of the bladder; (4) the presence of a superficial long femoral artery. As regards the comparison between the crested Agouti, guinea-pig, hare and rabbit, Messrs. Mivart and Murie find that the first differs from all the others and stands alone in the following particulars: (1) The number and arrangement of the pads of the pes and manus; (2) the greater extension of the levator claviculæ; (3) the absence of the rhomboideus capitis muscle: 5, 6, 7, 8, 9, and 10, refer to peculiarities of other muscles, which we fear are unfamiliar to our readers.

The Osteology of the Insectivora has also been very carefully studied by Mr. Mivart, but as the memoir in which his observations on this subject are stated appears in the May number of the *Journal of Anatomy*, we must refer our readers to that periodical for the particulars.

The Movement of Flight in Birds, &c., is the subject of a paper read in June last before the Linnean Society by Dr. J. B. Pettigrew. After pointing out the nature of the various forms of locomotion in animals, and showing the relation between the surface moved upon and the organs of locomotion, Dr. Pettigrew states that the body, or parts of the body, in all animals are presented and withdrawn from the several media by rotatory and spiral movements. These movements are for the most part produced by a judicious combination of ball-and-socket and hinge joints, the former occurring as a rule at the shoulder or pelvis, the latter in the limbs when present. The spiral movements are least perceptible in the extremities of land animals, but a careful examination of the structure of the joints, particularly the elbow and knee joints, and of their movements, will convince even a casual observer of their presence. They are more marked in animals which swim, the sea-bear twisting its flappers about with incredible dexterity, so as to present them obliquely to the water the one instant, and non-obliquely, or with their thin edge, the next. The same happens in the lower portions of the body in the seal and fish, the latter applying its tail to the water very much as an oar in sculling. The rotatory and twisting movements are still more perceptible in the application of wings, the pinions of the insect, bat, and bird being for this purpose twisted upon themselves. Dr. Pettigrew attaches considerable importance to this circumstance, and shows that but for the spiral conformation of the wing, and the fact of its being rotated on and off the wind during extension and flexion, the air could not be rendered subservient to the purposes of flight. He further shows that the more the wing is twisted, and the greater the number of its oscillations, the greater is its elevating and sustaining power. It would, therefore, seem that the screw, or a modification of it, enters into the structure of the bodies and extremities of all vertebrates, and that these are presented to the land, the water, and the air by spiral movements which remarkably resemble each other. Dr. Pettigrew's paper is illustrated by upwards of 70 original drawings, a large proportion of the figures being from living animals.

Blood Corpuscles of the Two-toed Sloth.—Professor Rolleston lately tested

the accuracy of Kühne's assertion that the sloth contains nucleated blood corpuscles; and the result of his observations has been the disproof of the German physiologist's assertion. The specimen examined was placed at Professor Rolleston's disposal by Mr. H. N. Moseley, of Exeter College, and was carefully examined under the microscope. Professor Rolleston states that the employment of a twelfth-of-an-inch object-glass by Messrs. Powell & Lealand has convinced Mr. Moseley and himself that, though a certain number of the dried blood-corpuscles of the sloth do contain one or more nuclei more or less roughly hewn, and irregularly and eccentrically placed, still the immense majority of them possess the non-nucleated character ordinarily assigned to the mammalian red blood-cell. The large size of the blood-cells of the two-toed sloth, the largest next to those of the elephant put on record amongst mammalian blood-cells by Mr. Gulliver, may, in more ways than one, have rendered an examination of them by a low power amenable to fallacy, and recourse to those of a higher power necessary. In the smaller corpuscles of the camel neither power enabled the observer to detect the presence of nuclei in the coloured blood-cells."—Vide *Quarterly Journal of Microscopical Science*, April.

Gregarine Parasites in Borlasia.—A paper was read some time since before the Royal Microscopical Society of London by Dr. W. C. McIntosh on the above subject. The author describes the parasite in general terms, and gives a more minute account of certain ova which accompany the gregarinaform body and are often extruded from the posterior end of the *Borlasia* under pressure. These ova measured about $\frac{1}{400}$ th of an inch in diameter, and each contained an embryo that, for some time after the extrusion of the egg, made very evident movements. They have two coats, an inner, faintly (concentrically) striated under pressure, and an external, without markings. The contained embryo is finely granular, and has a large pale nucleus; its various postures may be distinctly seen. When an ovum is ruptured between the glasses the contents spread abroad as a vast number of dancing granules.

A new species of *Ceistes* has been discovered and described by Mr. Henry Davis, who has made some curious experiments upon certain specimens. These experiments appear to demonstrate that in the species which he terms *Ce. intermedius* the ciliated "chin" is employed in manufacturing the tube which the animal inhabits. In proof of this belief Mr. Davis says that he has on several occasions noticed minute particles in suspension in the water drawn across and from the buccal aperture and directed by the cilia over the chin into a slight depression beneath it. The granules were not rotated nor formed into pellets, but they simply collected in a spot agreeing with the position of the pellet-cup in *Melicerta*. There was evidently a viscid excretion at the spot which held the extraneous matters loosely together in a clot; in about half a minute the rotifer would jerk down, leave the floccose deposit on the edge of its case, then rise immediately and repeat the process. On mixing a little carmine with the water, the process became very striking; an irregular crimson edge to the tube was made under Mr. Davis' observation, and, on leaving a number of specimens of both species in a zoophyte trough, charged with carmine, for forty-eight hours, he found that a few had continued building, and made red tops of different sizes to their habitations; nearly one fourth of the entire structure in two instances

was composed of the mixture of the red atoms and gelatinous excretion. One infant rotifer, whose first efforts at building he had distinctly marked, seemed to have made his entire nest of the glowing pigment.—*Vide Transactions of the Microscopical Society*, No. 26.

A curious larva has been described to the Dublin Microscopical Club, by Mr. John Barker. It was found in boggy ground in the Co. Wicklow. As we have ourselves met this interesting form in large colonies, in some of the Irish bogs we give the description of it for our entomological readers. The larva was in great part enveloped in a compressed quadrangular case, expanding towards the posterior end, elliptic in section; the aperture elliptic, semi-trumpet-shaped, everted and a little flattened. Through this the larva protruded its head and three pair of legs, which were long and, with the exception of the first pair, which were short and ended in a forceps, were armed with long and slightly curved unequal hooks. By means of its legs the creature crawled along the bottom and sides of the vessel, carrying the case swinging obliquely above. The two valve-like sides of the case approximated towards the base, so as to present a slit; it seemed composed of structureless chitine, with a few hairs on its surface. It was about $\frac{1}{30}$ " in length, and $\frac{1}{3}$ " broad at the base. The larva, after it had been in confinement about a fortnight, anchored itself by a sort of byssus to the sides of the vessel. First, a mucous substance was deposited on the glass at four different points; then four sets of cords (about fifty in each) united these attachments, two to the long axis of the mouth of the case, and two to the angles of the base. The animal lay much shortened, with its head curved round, its legs close together, entirely within the case.

The animal nature of sponges is demonstrated very clearly in a paper by Prof. H. J. Clark, in a late number of Silliman's *American Journal*. The American naturalist considers that the ciliated sponges are most closely allied to the monociliate *Infusoria flagellata*.

How to observe the reproduction of *Zoophytes*.—Dr. T. Stretchill Wright, in a paper on "British Zoophytes," gives some valuable advice to those who wish to study the mode of reproduction of zoophytes. His remarks have especial reference to the *Naked-eyed Medusa*. He says that the greatest care must be taken that the sea-water used in the experiment is perfectly free from the presence of the planuloid larvæ of other forms, which are frequently contained in water recently brought from the sea. The water must be slowly passed through filtering paper into a glass vessel capable of containing not less than three or four gallons, in which are placed a few fronds of *Chondrus crispus* or *Enteromorpha*. A few of the medusæ only should be placed in the vessel, amongst which it is advisable, but not necessary, that one should be a male with white and opaque, not transparent, spermatie sacs. The animals should be frequently fed with minute pieces of mussel or oyster. As soon as the planulæ appear they should be removed with a dipping-tube into a round glass shade inverted and filled with sea-water from the larger vessel, to which a few drops of mussel-juice must be added daily until it appears crowded with minute protozoa to serve as food for the future hydroids. The internal surface of the shade, and the surface of the water, should be examined often from without with an inch lens, and as soon as each planula adheres to the inside of the glass, a thin disc of microscopic

glass should be attached externally over its site with an interposed drop of glycerine, to ensure a flat surface, and the microscope, placed on a proper support, should be brought up to it armed with a power of about eighty diameters. The light, the quantity of which must be regulated by a diaphragm of blackened card or metal, should be reflected from a plane mirror, and carefully adjusted so as to pass through the water directly in the axis of the tube of the microscope. By this means the whole development of the planula into the hydroid zoophyte, with the successive development of the polypary, and the budding of the polype, may be seen in a very beautiful manner.—Vide *Journal of Anatomy*, No. ii.

Newspaper Zoology.—The *Pall Mall Gazette* has published the following interesting note:—"The *Courier de Saigon* reports some extraordinary items of natural history from the land of the Anamites. There is a certain fish, called Ca-ong in the language of the country, which has distinguished itself to that degree that the King has bestowed upon it the proud title of "Nam hai dui bnong gnan," which, as everybody knows, means "Great General of the South Sea." It appears that this laudable fish is in the habit of quietly paddling round the ships near the coast until somebody tumbles overboard. He then seizes him instantly, and, instead of eating him, gently carries him in his mouth to the shore. At Wung-tau, near St. James's Cape, they keep a skeleton of this extraordinary philanthropist. It is about thirty-five feet long, possesses front teeth like an elephant, very large eyes, a black skin very smooth, a tail like a lobster, and two wings on the back."

The Salmon in Australia.—There can be no longer any doubt of the success of the experiment in introducing the Salmon into Australia. The eggs were hatched, and the young were turned into the sea. From the sea they have returned, and are mounting the River Derwent. So states a recent letter from Dr. Officer, of Hobart Town. This is a great fact for fish-hatchers. Pisciculture is no longer a science simply, it is an useful art.

THE MICROSCOPE IN GEOLOGY.

By DAVID FORBES, F.R.S.

THE more searching and exact method of investigation now demanded by the advancing state of geological enquiry, necessitates that the student of that science shall in his researches avail himself of all possible means which the collateral sciences place at his disposal, and, amongst others, of those which can enable him to extend his powers of observation beyond the limits to which his unassisted eyesight can convey him.

As long as he encounters in the field only rocks of so coarse or simple a structure as to admit of their being resolved by the naked eye into their constituent mineral species, or of distinguishing the fragments of previously existing rocks, of which they may have been built up, he may speculate with a fair chance of success as to their probable origin or mode of formation. When, however, as is more often the rule than the exception, rocks are everywhere met with presenting so fine-grained and apparently homogeneous a texture as to defy such attempts at ocular analysis, all speculations as to their nature and formation based merely upon observation in the field, can but be compared to groping in the dark, with the faint hope of stumbling upon the truth.

In these cases the geologist must call in the aid of chemistry and the microscope; by chemical analysis he learns the percentage composition of the rock in question, and the microscopic examination informs him how the chemical elements are mineralogically combined, and at the same time affords valuable information as to the physical structure and arrangement of the components of the rock mass, tending to elucidate its formation and origin.

The microscope, employed some thirty years back by Ehrenberg in the examination of minute fossil organisms, is now recognised as having already done good service to palæontology, but was quite unknown to the geologist proper until within the last few years, when the admirable labours of Sorby have demonstrated the importance of the microscope as an indispen-

sable instrument of research in the study of physical geology and petrology, as well as indicated how much more may be expected from its more extended application.

The application of the microscope in these enquiries is as yet, however, quite in its infancy, for with the exception of Sorby's invaluable memoirs on some special points of enquiry, literally nothing has as yet been made public which could even serve as an introductory guide to the geologist who might wish to commence the study of the subject. It is therefore with great hesitation, and only after much solicitation, that the author of these remarks has now ventured into print, with the hope that by once breaking the ice, others more capable than himself may be induced to communicate the results of their researches on the same subject.*

In the present communication it is not intended to go into the details of any special microscopic investigation, but, as far as the space at disposal will allow, to attempt a short sketch of some of the results already obtained, in order thereby to illustrate the use of the microscope in similar enquiries, and to place the same before our readers in as plain and untechnical language as possible.

When applying the microscope to the examination of rock structure and composition, it is necessary to prepare the specimens previously, in order to be enabled to make full use of transmitted light in their investigation, since a mere inspection of their outer surface, viewed as an opaque object, although sometimes of considerable value, does not, however, give a tithe of the information which their examination by transmitted light will afford.

When in sufficiently thin splinters or laminæ, by far the larger proportion of mineral compounds allow light to pass through them with more or less facility, and amongst these, most silicates, chlorides, fluorides, carbonates, sulphates, borates, and other salts, as well as many oxides, and some few sulphides, sulpharsenides, &c. On the other hand, all native metals, alloys, and most of their combinations with sulphur, arsenic, antimony, &c., along with some few oxides and other compounds, are opaque, even when in the thinnest laminæ, and consequently when present, as they often are, in minute quantity in rocks, although sometimes recognisable by their external crystalline form, are

* In 1852 the author commenced the study of the microscopic structure of rocks and minerals by means of sections prepared by Ochatz of Berlin, but soon after commenced the preparation of the sections himself, in which he was under many obligations to the kind aid and advice of Mr. Sorby. At present his collection of sections of rocks, and their constituent minerals, amounts to above two thousand, and represents a wide geographical distribution.

not to be distinguished by their optical properties, as in the case of those bodies which, as before mentioned, are translucent.

When a mineral or rock under examination is entirely in the vitreous state, as, for example, obsidian, it appears when viewed under the microscope, merely as a more or less transparent or coloured glass, presenting, if perfectly in the vitreous condition, no evidence of crystalline or other structure, except perhaps traces of the striæ of viscid fusion. It is usually found on inspection, however, that some part of the mass is sufficiently deytitrified to allow of its structure and mineral composition being recognised. In some cases, when the glassy appearance presented to the eye would discourage any hopes of structure being discovered, the microscope proved the reverse most conclusively; as, for example, the section of glassy pitchstone from Arran, shown in Pl. XVII. fig. 4, in which the pyroxenic and felspathic constituents of the rock are beautifully apparent, notwithstanding that the rock itself looks like so much dirty green bottle glass.

In many cases, however, where the specimens are so perfectly in the vitreous state as to show no trace of structure whatsoever, this may be developed by carefully acting upon the surface by gaseous or liquid hydrofluoric acid.

The rock sections may be prepared for the microscope as follows: a fragment, from one-quarter to three-quarters of an inch square, and of convenient thickness, is chipped off the rock specimen in the direction of the required section, and ground down upon an iron or pewter plate in a lapidary's lathe with emery, until a perfectly flat surface is obtained. This surface is then worked down still finer by hand on a slab of black marble, with less coarse emery, then upon a Water of Ayr stone with water alone, and, lastly, finished by hand with water on a slab of black marble. By these means the surface acquires a sufficient polish without being contaminated with rouge or other polishing powder or oil, as is sometimes the case with purchased sections of rocks. This side of the rock is now cemented by Canada balsam on to a small piece of plate glass about $1\frac{1}{2}$ inch square and $\frac{3}{8}$ thick, which serves as a handle when grinding the other side on the emery plate as before; this grinding is continued until the section is so thin as to be in danger of breaking up from the roughness of the motion, upon which it is completed, by further grinding with emery by hand on marble, and finished first upon Water of Ayr stone with water, and afterwards upon black marble, as before described. The section is now removed from the plate-glass, and mounted in Canada balsam on a slide, covering its upper surface with a thin glass as usual.

The thickness to which such sections need be reduced is, of

course, entirely dependent upon the transparency of the rock constituents, and is commonly from $\frac{1}{100}$ to $\frac{1}{1000}$ of an inch.

Thin splinters of rocks and powdered fragments, mounted in Canada balsam, may also be examined with advantage, but cannot replace the above-described sections.

The examination of such a rock section enables a mineralogical analysis to be made, even of the most compact and apparently homogeneous rock, and generally leads to the discovery of other mineral constituents previously unsuspected, from their being invisible to the eye, and also, as Sorby has observed, allows those minerals, formed at the time of solidification of the rock, to be distinguished from such as are the products of subsequent alteration.

Arranging rock species according to their structure, it will be found that most rocks fall naturally into one or other of two great classes—

- I. PRIMARY OR ERUPTIVE ROCKS;
- II. SECONDARY OR SEDIMENTARY ROCKS;

and it will be seen that the microscope is of special value when applied in cases where the external appearance renders it doubtful as to which of these classes a rock may pertain.

The terms *primary* and *secondary* are here used quite independently of geological chronology. Primary rocks (of all ages) might be called “ingenite or subnate rocks” (i.e. such as are born, bred, or created within or below),* whilst the term “derivate rocks” would be appropriate for the latter, since directly or indirectly they are all derived from the destruction of the former.

I. PRIMARY OR ERUPTIVE ROCKS.

This class includes rocks which have made their appearance in many, if not in all epochs, from the most ancient to the most recent, from the old granitic outbursts to the eruptions of the now active volcanoes; and if, as is now generally admitted, the earth be regarded as having been once a molten sphere, the consolidated original crust of the globe would pertain to this class of rocks.

Mineralogically they consist of crystallised silicates, with or without free quartz, and usually containing many other minerals in minor quantities, especially metallic compounds, as magnetite,

* These rocks are indiscriminately called volcanic, igneous, plutonic, crystalline, &c. The term crystalline, although characteristic of these rocks, is not exclusively so, and is consequently less appropriate; many normal sedimentary beds, as rocksalt, gypsum, &c., are perfectly crystalline, and others when altered by metamorphic action, become more or less so.

titanoferrite, iron pyrites, &c., which last are frequently present in so minute a quantity as only to be detected by the microscope.

Whatever be their geological age, or from whatever part of the earth's surface they be taken, the microscopical inspection of such rocks shows immediately that they possess certain general and definite structural characters, distinguishing them at once from all other rocks.

The mineral constituents of such rocks are seen to be developed as more or less perfect crystals, at all angles to one another, thereby indicating that the entire mass must have been one time in a state of liquidity or solution (aqueous or igneous), sufficient to allow of that freedom of motion absolutely essential to such an arrangement of the particles.*

It would be impossible to do justice to this subject without more space, and many other illustrations, than are at disposal in this communication; some, however, which will serve to point out the general features of the structure of this class of rocks, are attempted in Pl. XVII. figs. 1 to 8, and Pl. XVIII. figs. 9 to 12.

The microscopic examination already made of many hundred sections of eruptive rocks, differing widely in geological age and geographical distribution, shows that in all rocks of this class, whether of the most compact, hard, and homogeneous appearance, or occurring in the softest and finest powder, like the ashes and dust frequently thrown out by volcanoes; a similar crystallised arrangement and structure is present and common to them all. Lavas, trachytes, dolerites, diorites, porphyrites, syenites, granites, &c., all possess the same general structural features, serving to distinguish the eruptive rocks as a class from all others.

In the examination and discrimination of the minerals which compose these rocks, especially when close-grained, the microscope is quite indispensable, since without it no such enquiry could be attempted. In these examinations, the assistance of polarised light is most valuable; but the space, unfortunately,

* Experiments show that analogous structure can be produced by at least three different methods, all of which, however, agree in the necessity of the mass being in a state of complete liquefaction previous to crystallisation; from—

1. Their solutions in water or other menstrea.
2. Aqueous fusion or melting of hydrated bodies in their water of crystallisation.
3. Igneous or hydro-igneous fusion.

Crystalline structure may nevertheless develop itself by a molecular movement in solid bodies without change of external form or previous liquefaction; as will be hereafter explained, this is frequently the case in nature. The structure so developed is, however, very distinct from the crystallisation after liquefaction, characteristic of the eruptive rocks.

only allows of a mere mention of its application. In distinguishing dolerites from diorites, when fine-grained, as is often of considerable geological importance, the fibrous structure of the hornblende of the latter is generally so well developed (Pl. XVII. fig. 6), even when present in very minute quantity, as to distinguish it readily from the augite of the former, which possesses no such structure. Even in the case of Uralite, a mineral characteristic of certain porphyritic rocks, which has the external form of augite, although its chemical composition is that of hornblende, the fibrous structure characteristic of hornblende is distinctly visible (Pl. XVII. fig. 7). The microscopic structure of some minerals, however, varies with their origin; thus Sorby has shown that the structure of augite, and some other minerals in meteorites, is quite distinct from that of the same minerals occurring in eruptive rocks, and demonstrated, in a very striking manner, how the study of such peculiarities is likely to clear up the mystery in which the origin of these bodies is involved.

When, as is often the case, especially with translucent, colourless minerals like quartz, leucite, calcite, felspar, &c., the appearance presented under the microscope is alike, their optical properties and the use of polarised light afford the means of distinguishing between them with certainty; as, also, in the event of one substance being present under two forms, as calcite from aragonite, monoclinic from triclinic felspars, &c. In a similar manner, the structure, whether crystalline or vitreous, is determined, and valuable information obtained, elucidating the mode of formation and origin of the rocks themselves.

The alterations produced in eruptive rocks subsequent to their solidification, by the action of water, atmospheric or other agencies, are studied with advantage under the microscope. For want of space, a single example can only be here given, and is depicted on Pl. XVIII. fig. 12.

In this section, the skeleton of labradorite is seen remaining as evidence of the original crystallised structure, whilst the interstices contain the products of the alteration of the more easily decomposable augite, the structure of which is nearly obliterated, and part of its lime converted into carbonate. The rock in question is the so-called "white horse" of Staffordshire, found embedded in or breaking through the coal measures, which are frequently burnt or altered at points of contact with this rock, which itself often has the appearance of a whitish clay. The origin of this rock, whether sedimentary or igneous, was disputed until the more recent geological and chemical examinations of it have proved satisfactorily its identity with the Rowley basaltic rock, very similar to that of Poukhill (Pl. XVII. fig. 5).

Pl. XVIII. fig. 13, is a section of a crystalline slag produced in

silver smelting, and is here given for the sake of comparison with the structure of eruptive rocks. In formation it is so nearly identical with what is seen in sections of more felspathic basaltic rocks, the mass of which consists of a framework of interlaced crystals of labradorite with the interstices filled up with the other mineral constituents confusedly crystallised, that this section might easily be mistaken for such. The Rowley rag, when fused and very slowly cooled, presents a similar appearance; and, in general, the structure of crystalline slags presents many features in common with that of ordinary eruptive rocks.

Before proceeding to the next class of rocks, the discovery by Sorby of the numerous minute fluid cavities in the quartz of granites should be alluded to, as proving the great value of the microscope in the study of these rocks. The result of this gentleman's researches* proves that granites have solidified at a heat far below the fusing points of their constituent minerals, and at such a pressure as to enable it to entangle and retain a small amount ($\frac{1}{4}$ to $\frac{1}{2}$ per cent.) of aqueous vapour, which naturally must have been present during its liquefaction. The presence of these fluid cavities in the quartz of granite was immediately blazoned forth as proof positive of the non-igneous origin of granite; whereas if Mr. Sorby's memoir had actually been read, it would have been seen that he had found fluid cavities, perfectly identical with those in granite, not only in the quartz of volcanic rocks, but also in the felspar and nepheline ejected from the crater of Vesuvius; and that the presence of fluid, vapour, gas, and stone cavities, are common both to the volcanic quartz-trachytes and to the oldest granites; and the inference drawn by Mr. Sorby from the results of his researches, is that both these rocks were formed by identical agencies. He therefore classes them together under one head as rocks of similar origin.†

II. SECONDARY OR SEDIMENTARY ROCKS.

The rocks pertaining to this class are all, directly or indirectly, formed from the breaking up, or *débris*, of previously existing

* Quart. Jour. Geol. Soc. vol. xiv. pp. 453—500.

† These researches tend to confirm the theory of the igneous origin of granite and eruptive rocks in general. It must not be forgotten that by *igneous action*, as used by the Plutonist, was always understood *the action of heat as developed in volcanoes* (the study of which was the basis of the theory itself), in which the agency of water was always recognised. Nearly half a century ago, Scrope not only insisted on the important part played by water in volcanic action, but specially pointed out the difference between such volcanic fusion and ordinary melting. The term hydro-igneous action might not be inappropriate for such, but hydro-thermalism does not at all express what is intended. The idea of a true dry fusion in nature exists only in the brains of the ultra-Neptunist or lukewarm hydrothermalist.

rocks, and, for that reason, might, as before mentioned, not inappropriately be termed derivate rocks. When found in the normal state of sedimentary deposition, they may be conveniently subdivided into—

1. Rocks formed of the immediate products of the breaking-up of eruptive rocks.
2. Rocks built up of the more or less rounded or angular débris of previously existing sedimentary or eruptive rocks.
3. Rocks composed of mineral substances extracted from aqueous solution by crystallisation, precipitation, or the action of organic life.

1. *Rocks composed of the immediate products of the breaking up of eruptive rocks.*—The little attention paid by geologists in general to the study of rocks of this class, has introduced the elements of confusion into many of their enquiries, and frequently has led to very erroneous opinions being formed as to the nature and origin of certain rocks, which could never have been entertained had microscopic investigation gone hand in hand with field observation.

Rocks of this class may either be of subaërial or subaqueous origin; in the former case, for example, volcanic ashes may have been deposited as beds on the surface of the land, and afterwards been covered by lava streams poured out over them; or, from having been depressed below the sea level, may have had sedimentary beds of aqueous origin subsequently superposed on them.

When of subaqueous origin, as is by far the most common case, subaërial or subaqueous outbursts may force into the sea eruptive rocks, which, being at once broken up into a state of division, more or less fine, in proportion to the greater or lesser cooling power of the water mass in immediate contact, may be spread out into beds by the action of the waves: the texture of these rocks may vary from that of the coarsest breccia down to the finest mud, and, as is usually the case, such deposits may present themselves as alternating beds of coarse and fine character. Upon the consolidation of such formations, rocks are formed, identical in chemical and mineralogical composition with the original eruptive rock from which they were derived, and which, particularly when close-grained, often present an external appearance so like the original rocks as to be frequently undistinguishable from them by the naked eye; in such deposits it is often easy to pick out specimens having all gradations in appearance from the above described down to such as would be attributed to the consolidation of mere detrital mud.

No wonder, therefore, if the field geologist finds himself

bewildered under such circumstances, and inclined to settle down in the comfortable belief of the transmutation or transition of sedimentary rocks into eruptive, &c., and even the chemist feels puzzled, when he finds that a rock taken out of apparently normal stratified deposits has the same chemical composition with one of undoubtedly intrusive nature. The microscopic examination, however, soon shows that, however similar the external appearance of two such rocks might be, their internal structure is totally different; showing in the primary rock the crystallised structure and arrangement previously described, whilst the secondary rock is resolved into a mere agglomeration of more or less broken fragments of the same minerals constituting the former. In beds formed from the consolidation of volcanic ashes, the microscopic examination occasionally affords evidence as to whether such ashes had been deposited on land, or had fallen into water.

2. *Rocks built up of the more or less rounded or angular debris of previously existing sedimentary or eruptive rocks.*—Where sufficiently coarse-grained, these rocks constitute ordinary conglomerates, breccias, grits, sandstones, &c., and are easily analysed by the eye; but if fine, as shales, slates, &c., the microscope must be appealed to, in order to resolve them into their constituent mineral or rock particles, and by this means it will be seen that even the most compact and homogeneous specimens are a mere aggregate of more or less rounded and water-worn grains of quartz, weathered felspar, mica, chlorite, soft and hard clays, clay slate, oxide of iron, iron pyrites, carbonate of lime, fragments of fossil organisms, &c., arranged without any trace of decided structure or crystallisation, even when the highest powers of the microscope are employed in their examination. The physical structure and optical properties of the mineral components enable them, however, to be recognised with great certainty, even when in grains of less than $\frac{1}{1000}$ of an inch in diameter.

Pl. XVIII. fig. 14, shows the appearance of a section of a fine-grained (uncleaved) Silurian clay slate from Sorata, in Bolivia, magnified 400 linear. This rock is composed of irregular grains of quartz sand, weathered felspar, and waterworn mica, along with specks of oxide of iron and iron pyrites, all promiscuously mixed.

In the case of roofing slate, however, the microscope shows that the constituents, instead of being distributed at random throughout the mass, possess a definite arrangement, as may be seen in the section of lower Silurian roofing slate from the Festiniog quarries (Pl. XVIII. fig. 15), where they are disposed in parallel lines, thus constituting lines of weakness or the cleavage of the slate. The researches of Sharpe and Sorby have con-

clusively proved that this has not resulted from any chemical or crystalline action whatsoever, the particles being in themselves perfectly unaltered; and that the arrangement is solely due to the effects of pressure, applied at right angles to the structure itself, thereby causing an elongation or flattening out of some, along with a sliding movement of other of the particles. The amount of compression to which an ordinary roofing-slate has been subjected in one direction, has been calculated, approximating from the elongation or distortion of the particles, to be about equal to one-half of its original volume.

Besides the cleavage structure, so produced by the compression of rocks whilst in a more or less plastic state, Mr. Sorby has shown that another system of minute jointing may also be present in these rocks, the serrated edges of which, as seen by the microscope, prove it to have been the result of force applied to the rock subsequently to its having been in a perfectly rigid condition.

Rocks of this class, when somewhat close-grained and much indurated, have not unfrequently, from their external appearance, been mistaken for intrusive rocks: thus the rock shown in section, Pl. XVIII. fig. 16, an upper oolitic, highly-inclined shale bed, has been mapped by D'Orbigny as an eruptive greenstone; the microscopic structure proves the contrary most conclusively.

3. *Rocks composed of mineral substances extracted from aqueous solution by crystallisation, precipitation, or the action of organic life.*—Under this class are included most beds of gypsum, rock salt, and other saline bodies, as well as travertine, siliceous sinter, flint, infusorial slates and earths, limestones, &c., many of which have been as yet but very superficially examined.

In the microscopic investigation of such rocks as owe their origin to the development of organic life, very considerable progress has been made, with correspondingly important and interesting results.

As early as 1836, Ehrenberg proved that large rock masses were built up of the carapaces of minute siliceous infusoriæ, and, more lately, Sorby has done good service by his investigation of limestones; these he has proved not to have originally possessed any crystalline structure whatsoever, but to have been deposited as mere mechanical aggregates (aptly termed by him, organic sands or clays) formed of the débris of calcareous organisms, which admit frequently, not only of being recognised, but of having their relative proportions determined. The comparison of the microscopic structure of the organisms in chalk, with those now forming in the depths of the Northern Atlantic Ocean, indicates that there is an immense deposit now in course of formation, quite analogous to what had previously taken place

in the seas of the cretaceous period; and the same able observer has shown that the reason why certain calcareous organisms are found so well preserved, whilst others had disappeared or become entirely disintegrated, was from the carbonate of lime in the first being in the form of the stable calcite, whilst in the latter it was present as instable Aragonite.

When a calcareous rock has undergone cleavage, the microscope shows a distortion of its particles and organisms, just as in a cleaved slate, though in much less degree; the measurement of such distortion serves as a basis for estimating the amount of compression undergone.

With the exception of having briefly referred to the alterations in igneous rocks, subsequent to their solidification, and the cleavage of sedimentary beds, all the classes of rocks treated of have been considered in their normal or unaltered condition; it remains now to direct attention to the use of the microscope in the study of subsequent alteration or metamorphism of rocks.

Many sedimentary beds become more or less indurated, at points where they are cut through by eruptive dykes; thus the coal-shales and clays of Staffordshire are found altered into a hard rock with conchoidal fracture, or even into porcellanite, when in immediate contact with basaltic dykes. An examination shows no change in mineral or chemical composition beyond the expulsion of the water always contained in such beds, and sections of such rocks are often seen to be quite identical in structure with those of common stoneware made from the same clays, the only difference being that the latter is usually more porous from not having been submitted to the pressure which rocks baked in situ would experience.

The alteration of rocks produced by infiltration may or may not be accompanied by chemical changes; thus a section of calcareous grit often shows that the calcite filling up the interstices between the grains of sand has been merely deposited from a solution of carbonate of lime which has percolated through it, and in otherwise unaltered limestones it is common to find microscopic veins of calcspar, due to minute cracks or fissures, filled up in a similar manner. Frequently, however, such infiltration is accompanied by an entire change in the chemical composition of the rock itself; thus the beds of Cleveland ironstone have been proved by Sorby's microscopical researches to have been originally shell limestones converted into carbonate of iron by the action of ferruginous solutions, the fragments of the original shells being still distinguishable in all stages of conversion; in the same manner he has proved the magnesian limestones of the Carboniferous and Devonian ages, as well as the Permian dolomites, to have been originally common limestones, or aggregations of organic débris, the particles of which, by the

use of the microscope, can be traced back to their original unaltered state, from which they have been changed by the action of magnesian solutions.

The metamorphism of rocks produced by gasolytic action, as, for example, carbonate into sulphate of lime, &c., has, as yet, not been made the subject of microscopical enquiry.

The foliated schists, quartzites, &c. form by themselves a distinct and well-defined class of metamorphic rocks, characterised by structural peculiarities differing from all previously treated of.

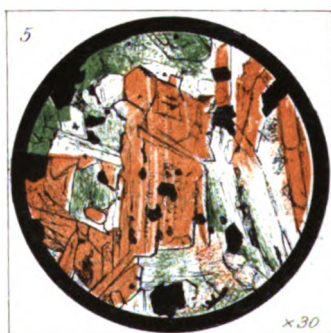
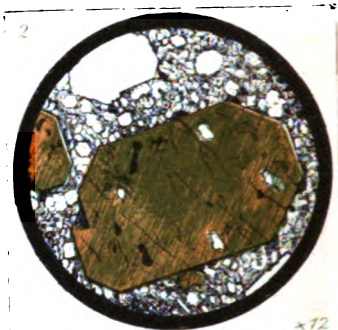
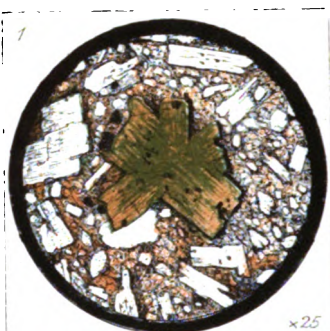
This appears to be due to their crystalline development having originated in a solid body, and not from liquefaction; the minerals composing them differ greatly in structure from the same minerals when found in eruptive rocks. Instead of, as in the latter case, presenting themselves in more or less defined crystals, occurring in all positions and at all angles to one another, in the foliated rocks they are developed only in one general direction, not characterised by well-defined bounding planes, but forming a string of drawn-out and irregularly bounded crystalline aggregations, presenting a general parallelism to one another, as is illustrated by Pl. XVII. fig. 8, which shows a section of hornblende schist from Connemara.

The microscopic examination of these rocks proves their original sedimentary origin, often showing the contours of the original sand grains, and, as Sorby has pointed out, the existence of ripple-drift and wave-structure, peculiar to sedimentary rocks alone. These rocks appear to have been micaceous and argillaceous sandstones, the constituents of which have been recrystallised in situ, owing to molecular action developed in the solid rock.

The quartz of these schists frequently contains numerous fluid cavities, indicating that they have been exposed to a pressure under which the water, always present in more or less quantity in sedimentary rocks, has been entangled and retained during the recrystallisation of the quartz.

The direction of the lines of foliation or crystalline development is that of the lines of least resistance in the rock, which commonly will be the lines of stratification, but in cleaved rocks will doubtless be those of cleavage. Sorby has alluded to this fact by the names of "stratification foliation" and "cleavage foliation."

In conclusion, the author of this short sketch hopes that it may be the means of attracting attention to the subject, and thereby of causing a hitherto almost unexplored field of microscopic enquiry to be more cultivated; and leaves it to his readers to form a correct estimate of the justness of the sneering assertion that "mountains should not be looked at through microscopes."



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DESCRIPTION OF PLATES.

PLATE XVII.

FIG. 1. Section of greyish black slaggy lava from Etna, magnified 25 linear. Although this rock appears perfectly amorphous to the eye, it is here seen to be composed of crystals of greenish brown augite, colourless felspar, and opaque magnetic oxide of iron; the interstices being filled up with an admixture of the same minerals less distinctly crystallised. This specimen was, by means of a pole, lifted by the author, on the 21st of May, 1865, out of the grand current of lava then flowing out from the north side of the crater of the volcano.

FIG. 2. Section of lava from Vesuvius, magnified 12 linear. This specimen was taken by the author from the current of A.D. 79 covering Herculaneum, and was a somewhat porous, but hard dark grey rock, containing abundant crystals of augite, which are well shown in section.

FIG. 3. Section of a volcanic rock, magnified 12 linear, consisting of felspar with some olivine and magnetic oxide of iron, with numerous crystals of a pyroxenic mineral, all well shown in this section. The specimen was taken by the author from the Valley of Papenoo, in Tahiti.

FIG. 4. Section of the pitchstone occurring in dykes breaking through the new red sandstone in the island of Arran, magnified 75 linear. In external appearance it resembles a dirty green bottleglass, but under the microscope shows a beautiful arborescent crystallisation of a green pyroxenic mineral, embedded in the colourless and transparent felspar base.

FIG. 5. Section of a portion of a basaltic column from Poukhill Quarry, near Walsall, Staffordshire, magnified 30 linear. This rock intrudes into and disturbs the coal measures, and is seen to be composed of crystals of felspar, augite, and titanoferrite, with a little of a green mineral, probably the variety of augite called seladonite.

FIG. 6. Section of diorite (auriferous), taken by the author from near Tres Puntos, in the Desert of Atacama, Chili, magnified 30 linear. It consists of felspar with hornblende, and, in the section here represented, groups and isolated crystals of iron pyrites are seen, which frequently accompany this rock, and with which the gold is associated.

FIG. 7. Section of uralite porphyry, from Predazzo, Tyrol, magnified 12 linear. It is composed of felspar with uralite, a mineral having the external crystalline form of augite, with the chemical composition of hornblende.

FIG. 8. Section of hornblende schist, cut at right angles to the plane of foliation, and magnified 12 linear. It is composed of hornblende and quartz, the latter recrystallised, but still showing traces of the outlines of the original sand grains: upon examination under a higher power, the quartz will be seen to contain numerous fluid cavities. The parallelism of the foliation, although perfect when viewed on the large scale, is naturally somewhat indistinct in a fragment so small as can be taken into the field of the microscope. It is evident, upon inspection, that the structure of such a rock is totally different from that seen in the sections of eruptive rocks.

PLATE XVIII.

FIG. 9. Section of granite from St. Just, Cornwall, magnified 25 linear. It consists of crystals of orthoclase, hexagonal ditto of brown mica, and of colourless quartz; the latter, when examined by a higher power, is seen to contain fluid cavities.

FIG. 10. Section of volcanic quartz trachyte from Jacna, Peru, magnified 10 linear. It consists of quartz crystals, often large and well defined, along with smaller hexagonal plates of black mica, scattered through a felspathic mass indistinctly crystallised. The quartz of this trachyte also contains fluid cavities (seen by employing a higher power), similar to those occurring in the quartz of granite. This rock is developed very extensively along the volcanic range of the Andes of South America.

FIG. 11. Section of a volcanic rock, taken by the author from the foot of the volcano of Ariquipa, in Peru, magnified 6 linear. This rock is of a grey colour, and has a porphyritic structure, arising from crystals of white felspar, scattered through a grey base, which the microscope shows to be composed of felspar, dark brown-black crystals of augite, hexagonal crystals of almost black mica, and a little magnetic oxide of iron.

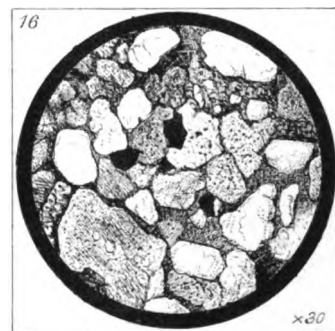
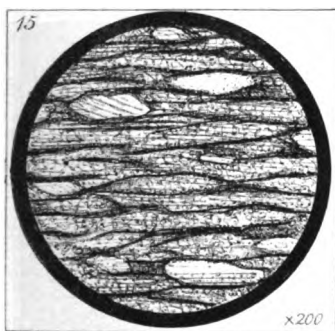
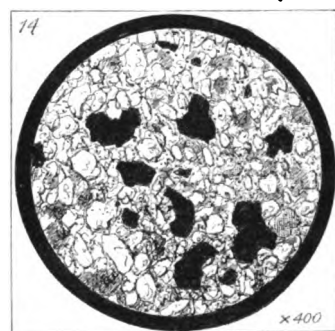
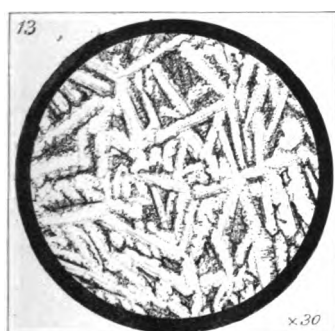
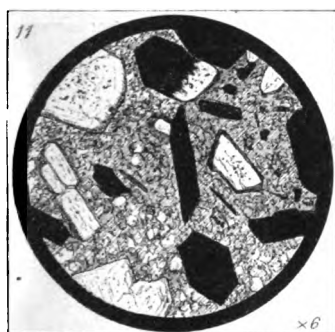
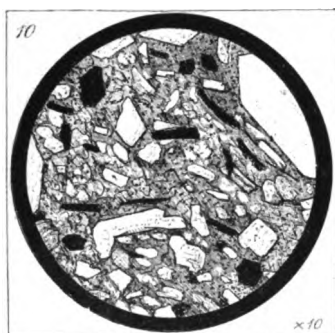
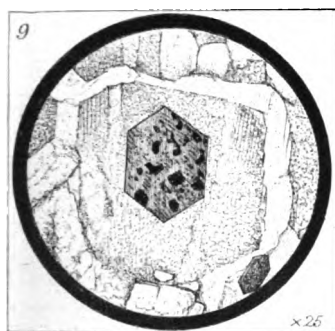
FIG. 12. Section of the so-called "white horse" dykes, intersecting and altering the coal measures of Staffordshire, magnified 35 linear. The framework of felspar crystals still remains unaltered, whilst the other mineral constituents are decomposed so far as to be frequently unrecognisable. Its chemical composition, in conjunction with the microscopic structure, show this rock to be similar to that from Poukhill (Pl. XVII. fig. 5), more or less altered by the action of water.

FIG. 13. Section of a crystalline slag from smelting silver ores, magnified 30 linear. The structure is seen to be very similar to that found in many of the more felspathic doleritic rocks.

FIG. 14. Section of fine-grained Silurian (uncleaved) slate, from Sorata, in Bolivia, magnified 400 linear. It is seen to be a mere mechanical aggregate of minute, irregularly weathered, or rounded particles of sand, clay, mica, oxide of iron, &c., without any trace of arrangement or crystalline structure being visible.

FIG. 15. Section of Lower Silurian roofing-slate, from Festiniog, North Wales, cut at right angles to the cleavage, and magnified 200 linear. This shows that the parallel structure of cleavage is due entirely to the mechanical arrangement of the unaltered particles of the rock, and not to the development of any crystalline structure.

FIG. 16. Section of a highly indurated bed in the upper oolitic series at Huaylillos, Peru, magnified 30 linear, and in external appearance so much resembling an eruptive rock as to have been mapped as such by D'Orbigny. The microscopical examination, however, at once shows its true sedimentary character, and resolves it into a mere mechanical aggregate of quartz, sand, &c., without any of the crystalline character peculiar to eruptive rocks.



WHY THE LEAVES FALL.

By MAXWELL T. MASTERS, M.D. F.L.S.



SCARCELY less wonderful than the gradual advent of the leaves in spring, is their successive disappearance at the close of autumn. In every age moralists and poets have found illustrations for their themes in the hopeful bursting into leaf of the tree in spring, or in the inevitable fate which in early winter breaks up the rich billowy masses of foliage, and sends

"The sere leaves flitting on the blast."

It is remarkable how many analogies may be drawn between natural phenomena and the attributes of human nature. Now we find the life of man compared to a river, at another time to a glacier, it may be to a cloud; but however apposite these comparisons may be, they are certainly not more so than is the analogy that may be drawn between the life of the leaf and that of the human race. Both have an innate power of growth, in both equally are the seeds of decay early implanted, which develop and fructify in due time, counterbalance the powers of growth, and ultimately bring the worn-out structure to the ground.

"Like leaves on trees the race of man is found,
Now green in youth, now withering on the ground;
Another race the following spring supplies,
They fall successive, and successive rise;
So generations in their course decay,
So flourish these, when those have passed away."

But now-a-days we are not content merely to draw analogies, however correctly; we leave the poet to make his own use of the facts presented to him by adorning a moral or pointing a tale, but more prosaic people seek to know the why and the wherefore of the facts presented to their notice, and thereby, in spite of what may be said to the contrary, to increase the store of illustrations for the poet by opening up to him new marvels and deeper and more comprehensive analogies.

Why, then, do the leaves fall? is the query to which we purpose in the present article to supply a response as far as we are able to do so.

In attempting to give an answer to the question, it may be as well to go a little into detail, which will serve the more clearly to render intelligible what really is known about the fall of the leaf, and will also indicate certain points which up to the present time have scarcely received a satisfactory explanation.

We may premise that all the many reasons that have from time to time been given to account for the process of defoliation may be ranged into those which are of a purely mechanical nature, and which are very much under the influence of external conditions of climate and the like, and those which are of a structural or organic character, being only secondarily mechanical in their action, and less directly influenced by external conditions.

There are such differences in the length of time that leaves remain attached to the stem, such variation in the method of detachment, that it would seem probable that the causes producing these varied results may themselves be diverse, that in one case one cause may be potent, in another instance the result may be due to some other agency, while in a third series, perhaps, the effect may be the result of the joint action of more than one factor. Thus, while some leaves fall off comparatively soon after their expansion, such as those which are technically termed caducous or deciduous, others are persistent, while to a few, which seem never to be shed, the term evergreen, which is generally inappropriate, may fairly be applied. Where leaves fall off very early, it will be found generally that they serve the purpose of protection merely; such are the small rudimentary scaly leaves which envelop the leaf-buds in most of the trees and shrubs of this country. Formed at the close of the year around the young bud, they shield and protect it during winter, and when the returning warmth of spring urges the dormant bud into growth, the scales are pushed off by the constantly increasing pressure of the rapidly enlarging bud. On the other hand, where, as in the *Araucaria*, the leaves are never shed, their internal organisation approaches in many respects to that of the stem; indeed, it becomes a question in such a case whether the so-called leaves are not merely portions of the stem. Between these extremes there is a large class of deciduous trees or shrubs, which shed their leaves, some sooner, some later, but at a tolerably regular, determinate period, according to the particular species, and according, as we shall see presently, to external circumstances. Thus, while the lime, in the southern parts of Britain, loses its leaves early in September, the walnut soon afterwards, to be followed in their turns by the elder and the horse-

chestnut, there are others, such as the beech, the hornbeam, and some varieties of oak, which retain their leaves for the greater part of the winter, though generally in a dried, withered state, and do not part with them till forced to do so in spring by the gradual distension of the newly awakened buds.

Gardeners were wont at one time, much more than at present, to make use of hornbeam hedges to afford shelter to their plants in winter, just as they do now with hedges of yew. In Holland, it is not unfrequent to see the brown withered foliage of the beech, or the hornbeam, contrasted with the rich dark green of the ivy, and making a screen at once useful and agreeable to the eye. It is noteworthy, that, in the case of the beech at least, the petiole becomes quite woody in its texture, and is not so easily cast off as some wherein the tissues are softer.

Plants, too, have their idiosyncrasies as well as other creatures. There are some which will develop their leaves a fortnight or so earlier than their brothers of the same species, others that will retain their foliage long after it has fallen from other plants of the same specific form. This did not escape the notice of the old Greek naturalists, for Theophrastus, in his work "*De Plantis*," mentions a plane-tree in Crete, which never shed its leaves, and he adds, that that was the identical tree beneath whose shade Jupiter carried on his flirtation with Europa. Be that as it may, it is quite certain that, apart from individual peculiarities, such as we have just mentioned, plants of the same species will shed their leaves sooner or later according to the locality in which they grow. In the Canary Islands the vine only sheds its foliage very gradually, so that new leaves often appear before all the old ones are thrown off. The cherry-tree in Ceylon, and the peach in Brazil, are said to become almost completely evergreen. On the other hand, in colder latitudes than ours the leaves fall earlier, in consonance with the earlier advent of winter. In the tropics, although there is in general not so well-marked a period of defoliation, yet the dry season seems to act in a similar way to the winter season here. Travellers tell us that there is scarcely a month in the year in which young shoots and leaves may not be seen on the trees, so that the formation of the young leaves, as well as the fall of the old ones, is spread over the whole year, as it were, and is not so much confined to particular periods as in temperate latitudes. The fall of the leaf cannot, however, be attributed solely to the change in the seasons from wet to dry, or from hot to cold, for it not unfrequently happens that if a tree be stripped of its leaves in summer, it forms during the autumn new ones, which remain on the tree during the greater part of the winter, or at any rate until long after the usual period. A similar occurrence was noticed in the Calcutta

Botanic Garden by Dr. Anderson, after the terrific cyclone of October 1864. Several trees which were denuded of their foliage by the wind produced new leaves, which, in place of falling off as they do under ordinary circumstances in winter, remained on the trees throughout that season. These trees did not, however, flower in the following spring, as they would have done had there been no interruption to their ordinary course of proceedings. On the other hand, some others, although they produced a second crop of leaves after the cyclone, lost them again in the winter, and flowered as usual in the spring. These facts are very suggestive as to the relative interdependence of leaves and flowers; a subject which we must not, however, dilate on in this place.

Drought seems to have as potent an effect in bringing about the fall of the leaf as cold. In some of the Brazilian forests during the dry season the trees are as bare as with us in the depth of winter; and a few summers since, when there was a long period of drought, the trees on the sandy dry soil about Bromley in Kent were as bare as in winter. Reasoning upon facts such as these, it is not unnatural to conclude that the fall of the leaf is in some way or other connected with evaporation or exhalation of fluid from their tissues. This, as is well known, takes place to a large extent, being regulated partly by external circumstances, partly by internal organisation; and it has been proved experimentally by Lawes and others, that the so-called evergreens, as a rule, evaporate less in proportion to the extent of their leaf surface, than do ordinary plants; and coupling this fact with the known effects of drought on deciduous trees, it is reasonable to suppose that the fall of the leaf is, in a measure at least, dependent on the evaporation from the surface. This explanation, however, is only partially satisfactory, for it will at once be seen that in most cases the leaves fall not at a period of drought, but in early winter, a time of comparative humidity, when heat or drought, at any rate, would not give rise to disproportionate exhalation.

Adverting now to the external configuration of the leaf, let us see whether there may not be some mechanical cause for the separation of the leaf from the trunk. In most cases the leaf-stalk is attached by a broad base to the stem, so that when it falls off it leaves a scar more or less like a horseshoe in shape: on this scar may be seen the traces of the bundles of woody tissue, which passing from the trunk traverse the petiole or leaf-stalk on their way to the blade of the leaf, where they break up into the so-called veins. Now an observation of the shape of the scars, and of the disposition of the bundles of woody tissue in them, in different plants, throws some light on the causes of defoliation; for instance, it is reasonable to surmise that where

the leaf-scar is circular, in other words, where the leaf-stalk is cylindrical, and the bundles of woody tissue are arranged in a ring, the leaf would be less easily detached than in cases where the bundles form a half-circle, merely leaving the upper surface of the leaf-stalk comparatively weak from the presence of cellular tissue only. In any case, the leverage exerted by the flat surface of the leaf, acted on by every wind that blows, must be taken into account.

Another reason that has been suggested for the removal of the leaves, is the pressure exerted on the base of the leaf-stalk by the axillary buds, which swell and increase in size notably in the autumn; but there are many things which show that the swelling of the bud at this time of year has but little to do with the shedding of the foliage; for see how carefully pressure is provided against by the flattening of the leaf-stalk at its base, or even by its being scooped out spoon fashion to receive the bud. Again, notice how often, when there is a chance of injurious pressure being exerted, the stem bends away from the leaf at an angle, as in what are called "flexuose" stems, so that no hurtful pressure can take place. For the purpose of testing this notion, we have, while writing these notes, observed a young lime, which even thus early (August 7) is shedding its leaves. The lime is a good tree to notice for this purpose, because its stems are often more or less flexuose, and because its leaf-buds are placed a little on one side of the leaf-stalk, and not immediately in their axil; moreover, as happens of course with other trees, only a small proportion of the leaves foster in their axils buds large enough to exert any possible pressure. The vast majority of the axillary buds remain "latent."

Now it might be expected, if it were true that the newly formed buds pushed off the old leaves in autumn, that the lime-tree would retain its leaves longer than most other trees, seeing that its buds are not so placed as to be able to exert much pressure, and that the stem is more or less flexuose. But what is the case? The lime is one of the earliest trees to part with its leaves, and as the writer has observed, not only in the lime, but in other trees, the presence or absence of an axillary bud does not seem to make the slightest perceptible difference, either in the period at which the leaves fall, or in the amount of force requisite to detach them artificially. For experiments of this kind, the common and the Neapolitan alder are suitable, inasmuch as some of the buds in these trees are raised upon short stalks, which, growing comparatively fast just before the fall of the leaf, might be supposed to exert some influence on that phenomenon. But here, again, the comparison of those leaves which are provided with stalked buds, and those in which no bud or only a rudimentary one is visible, does not show any

difference as to the period when they fall, or as to the weight requisite to detach them. The influence, then, of the axillary buds in detaching leaves in autumn (a very different matter from the separation of the persistent leaves in spring by the same organs), would seem to be *nil*, and we may turn to other assigned causes. Among these are the formation of earthy or mineral materials in the tissues of the leaf, to such an extent as to block up the cells and impede their action. That such an accumulation does take place, is easily proved by chemical analysis and microscopical observation. The latter shows a much larger proportion of raphides or crystalline deposit in the cells in the leaves about to fall than at other times. The falling leaves of the common cherry laurel, *Prunus lauro-cerasus*, may be cited as affording a good illustration of this accumulation of raphides, the more so as the leaves of this plant, as of most of the so-called evergreens, are not shed in greater numbers at the approach of winter than at any other time, but are irregular in this respect. The accumulation of earthy matters in the leaves serves to restore to the ground in some measure the mineral ingredients taken from it by the growing plant; hence the impolicy of the practice, so often followed in gardens to the detriment of the shrubs, &c., of removing the fallen foliage from the soil; if such be necessary for purposes of neatness, some other provision should be made to supply the soil with what is requisite for the growth of plants. The storage in largely increased quantities of starch granules in the cells, has also been noted by Dr. Inman and others, as taking place in leaves just previous to their fall; and it is easy to conceive that the distension of the tissues, and the impediment offered to the due discharge of their functions, might facilitate the separation of leaf and stem.

But in the face of the facts already mentioned, and especially when it is recollected how very "clean" is the fracture between the leaf-stalk and its attachment, how it is nearly as even and smooth as if the severance had been made with a knife, it becomes evident that whatever influence the circumstances before mentioned on the phenomena in question may have, they can but be secondary and indirect, and we are driven to seek some cause in the organisation of the leaf itself. At one time it was considered that the varying direction of the several layers of tissue in the leaf-stalk would account for their separation, and this would seem borne out by the very common arrangement of the wood cells of the leaf-stalk, nearly at a right angle to the cellular tissue. This arrangement may be seen in many leaves, as in *Rhus typhinum*, *Gleditschia*, &c., but according to Von Mohl, it is far from being general. Schacht's notion was, that the fall of the leaf was due to the gradual intrusion of a layer of cork

or periderm cells, which, passing through the leaf-stalk at nearly a right angle to the other tissues, prevented the passage of the sap from the stem to the leaf, and ultimately caused the detachment of the latter, pretty much in the same way as that by which the removal of the large slabs of bark from the plane-tree is effected. Von Mohl, however, shows that this statement of Schacht's is too general; that the periderm layer is as often absent as present; and so far as we have ourselves noticed, the periderm cells are often not formed till after the fall of the leaf, when they gradually extend over the wound, and close it as by a plaister. Von Mohl's account of what happens is as follows:—Shortly before the fall of the leaf, there begins to be formed a very delicate layer of cells, the growth of which is from above downwards, so that, beginning from the axillary side of the leaf, and gradually extending downwards and outwards nearly at right angles to the long diameter of the cells of the leaf-stalk, at any rate at right angles to the plane of the leaf, it effects a gradual separation between the stem and the leaf as effectually as a knife would do. The layer in question does not separate, as might be supposed, the comparatively dry distal portions of the leaf, from the still active cells of the stem, which are filled with juices, but it is formed in the midst of soft tissue, the cells of which are turgescient with fluids. It is, therefore, not so much a separation of dead from living tissue, as a passage of an active "line of demarcation" through living, still active tissue. This "separating layer," unlike the periderm cells of which Schacht speaks, is composed of young tissue endowed with a large share of vitality; its cells are usually filled with starch and with albuminoid matters, indicative of a young and active tissue. The vessels of the petiole, according to Von Mohl, are not affected at all by these changes; they simply become broken through as the leaf falls. We allude to the spiral and pitted vessels especially, and not to those "*vasa propria*" which have of late been so minutely studied by M. Trécul. The latter observer, in the *Comptes Rendus*, July 1, 1867, p. 25, mentions the formation, in the *vasa propria*, of a layer of cells, just prior to the fall of the leaf, in several plants. The effect of this formation of new cells is to fill up and completely obstruct the reservoirs of secretions. These cells are said by M. Trécul to be formed from the subdivision and growth of those forming the boundaries of the channels in question, and thus are wholly different from those constituting the separating layer of Von Mohl, though it is obvious that they must have a similar effect in promoting the detachment of the leaf from its support. It may be as well to point out that the circular constriction so often seen at the base of a leaf-stalk, forming the joint, or articulation, as it is called, exists from the beginning, and while it indicates

nearly the ultimate position of the "separating layer," yet it is not itself to be considered as the commencement of that layer.

The constriction may readily be seen throughout the whole summer, and by microscopical examination it may easily be noticed to be purely superficial; moreover, it is much more marked on the lower than on the upper surface; while the "separating layer," on the other hand, travels, as we have seen, from within or from above downwards and outwards. The reader will find it easier at any time to detach a leaf from the stem by bending it downwards than by forcing it upwards, a result that would be reversed if the constriction were really, as it is so often considered to be, the provision made aforetime for the ultimate removal of the leaf. What, then, is this constriction? To answer this question, we must refer to Eichler's thesis on the development of leaves, of which Dr. McNab* has given an abstract in English with comments and additional observations of his own. According to these observations, the first stage in the formation of the leaf is the production of a little pimple of cellular tissue on the side of the stem; this receives the name of "phylloblast," and after a time it divides into two portions, a proximal portion next the stem, which Dr. McNab calls the "hypophyll," and a distal portion called the "epiphyll;" from this latter, the true leaf with its stalk is evolved, from the former (which seldom assumes any large size) the stipules are produced when these organs are developed.

Applying these facts to the fall of the leaf, it will be seen that the separation takes place below the swollen base of the leaf-stalk, beneath what is technically called the "pulvinus," and hence the constriction so often seen in that situation indicates the original line of separation between the "hypophyll" and the "epiphyll." This at any rate seems very probable. But whether this be so or not, the detachment takes place, not precisely between leaf and stem, but between leaf and "hypophyll," the latter being intermediate in position between leaf and stem, and structurally more nearly allied to the latter than to the former. The formation of a separating layer in the way we have explained is not unique; analogous instances may be seen in the fall of the fruit. On the freshly detached surface of a pear-stalk, a white mealy appearance may be seen by the naked eye; on microscopical examination this will be found to be due to the formation of a layer of new cellular tissue.

On the whole, then, of all the assigned causes for the fall of the leaf, this last, dependent on an alteration, or rather on a new growth in the leaf itself, is the most important, and probably the only one of itself sufficient to produce the result. It remains now

* Trans. Bot. Edinb. 1865, 1866.

to be seen whether this separating layer is of universal formation in the case of deciduous leaves. For many reasons we are inclined to think that it is not formed when leaves fall off prematurely, as they do from drought or injury. But supposing it to be of general occurrence under what we may term ordinary circumstances, it still remains to be ascertained what are the precise conditions inducing the formation of this peculiar layer of tissue. It is easy enough to say that the layer in question is formed owing to the disproportionate growth of the tissues, those of the stem being active, while those of the leaf are obstructed and comparatively inert. This may be so, but there is no direct evidence on the point as yet. We admit the facts, but the precise relation of those facts one to another is not yet fully made out; till this is done, the explanation of the fall of the leaf cannot be considered as fully satisfactory.

"A MESSAGE FROM THE STARS."

By ROBERT HUNT, F.R.S.

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AN attentive study of the philosophy of the experimental sciences, will speedily lead to the conviction, that many of the simplest phenomena, which, from their constant recurrence, are ordinarily regarded as common-place and insignificant, contain the germs of truths of the most exalted character. The laundress who spat upon her smoothing-iron to determine if it was hot enough for her purpose, never dreamed of the "spheroidal state" of matter, or fancied that her simple test would lead to important discoveries in connection with heat, or advance us to the magical experiment of freezing water in red-hot vessels. Yet so it was.

With the spontaneous evaporation of water—the drying of linen for example—everyone has been acquainted for ages. Yet this diffusion of vapour into the air failed to teach man a great truth until recently. The adhesion of water to a perfectly smooth and clean piece of glass, and the "sucking up" of the same fluid by a sponge, or by a lump of white sugar, though constantly observed, never instructed the observer until lately in the action of material surfaces on fluids and gases, or indicated to him the existence of a Force, or Forces, surrounding every atom, which appear capable of exerting an intense mechanical power of condensation. The careful study of these phenomena has, however, gradually advanced us from one discovery to another, until it has enabled us to read with precision a great truth, brought to us by a Meteorite, which once moved in the remote spaces through which comets travel, and where nebulae are slowly concreting into worlds. It is necessary for the correct understanding of the curious results obtained by Mr. Graham, which have advanced our knowledge by certain steps, to the remarkable discovery of the *Occlusion of Hydrogen Gas by Meteoric Iron*, that we should concisely trace the progress of the enquiry from its earliest development.

To Dr. Priestley* we are indebted for the earliest observations

* Priestley, "Experiments and Observations on Different Kinds of Air," iii. p. 29.

we possess in relation to this subject. Having occasion to transmit a gas through stoneware tubes surrounded by burning fuel, he discovered that the tubes were porous, and that the gas escaped outwards into the fire, while at the same time the gases of the fire penetrated into the tube. Priestley does not appear to have had any idea of the value of this observation: it was to him a barren fact. Dr. Dalton perceived the important indication, and clearly saw the bearing of Priestley's observation on the properties of aerial bodies. Experiments, well devised and cautiously varied, led him to the discovery that any two gases, allowed to communicate with each other, penetrated each other, or mixed, in opposition to the influence of their weight. Taking the lightest known gas, *hydrogen*, and the heaviest, *carbonic acid*, he placed them in two vessels which communicated with each other, so that the dense gas was in the lower vessel. According to the solicitation of gravity, the two gases should have remained as they were arranged; but it was found that the lighter gas descended and the heavier one ascended, until, in a few hours, they became perfectly mixed.

But for the operation of this diffusive power, the healthful condition of the Earth's atmosphere would not be maintained. When a light and heavy gas are *mixed*, they do not exhibit any tendency to separate on being allowed the most perfect repose. Common air is essentially a *mixture* of oxygen and nitrogen: these gases differing in weight in the proportion of 971 to 1105. Yet if a closed tube of air, many yards in length, be kept upright and perfectly still for months, no change whatever takes place, the air at the top and that at the bottom of the tube being in precisely the same condition. If, however, into a similar tube we pour a heavy gas, and then carefully float on it a light one, they will have diffused thoroughly in a few hours, every portion of the tube containing the same mixture.

Mr. Graham found that gases diffuse into the atmosphere, and into each other, with different degrees of ease and rapidity. His mode of observing this was by allowing each gas to diffuse from a bottle into the air through a narrow tube, arranged in such a manner that the gas had no tendency to *flow out*, but was compelled to *diffuse* in opposition to the effect of gravity. Each gas penetrates into the space occupied by the other, not at the same rate in both directions, but according to a well-determined law. To express this disposition—or rather diversity of disposition—in gases to interchange particles, the term *diffusion volume* has been adopted. The diffusion volumes are inversely as the square root of the densities of the gases, and the times of effusion and diffusion follow the same law.

It has been found convenient to adopt with precision the following terms: *effusion*, or pouring out—this expresses the

passage of gas into a vacuum by a small aperture in a thin plate; *transpiration*, the passage of gases through tubes of fine bore and of some length; *diffusion*, or the power of interpenetration; and *evaporation*, which is the ordinary process of spontaneous vapour diffusion.

The general laws which regulate the latter alone need claim our attention. It is desirable to show that the ordinary process of evaporation is one of diffusion, and that, differing only in degree, it presents a striking analogy to the diffusion of gas through gas, and of fluid through fluid. The spontaneous evaporation of water into air is affected by three circumstances. 1st. The dryness of the air. A certain fixed quantity only of water vapour can rise into air. Dr. Dalton discovered that the evaporation of water has the same limit in air, as in a vacuum. It is only necessary to know what quantity of any vapour rises, at a particular temperature, into a vacuum, and we learn the quantity which will rise into air. 2ndly. The influence of warmth in modifying spontaneous evaporation; and 3rdly, the removal of the incumbent air as it becomes saturated with moisture. Hence the advantages of a current of air for rapidly drying a wetted surface.*

Döbereiner of Jena made the first observation on the escape of hydrogen through a crack in a glass receiver. He did not observe the whole phenomenon; he ascribed it to capillary action, which indeed it resembles in some respects. It was reserved for Mr. Graham to clear the difficulties and give a correct interpretation of the law. In repeating Döbereiner's experiments under different forms, he observed that hydrogen never escapes outwards by the fissure without a certain portion of air penetrating inwards. Extending the experiments, and adopting an instrument which would measure the rate of the interchange, it was found that the diffusion of gases through fissures, or through porous septa, is regulated by the same law as when they freely communicate with each other. *The relative diffusibilities are inversely as the square roots of the densities.*

It has now been determined that diffusion will take place at different rates—though always at the same rate for the same substance—through such porous bodies as wood, cork, charcoal; thin slips of many granular foliated minerals, as magnesian limestone; through unglazed earthenware, slices of plumbago, and Carrara marble. These porous bodies may be regarded as a series of capillary tubes. The resistance of a

* The papers by Dr. Dalton, and those by Professor Graham, should be consulted on this interesting subject; but, beyond all, "*Études sur l'Hygrométrie*," by M. Regnault, "*Annales de Chimie*" (1835), should be studied.

capillary tube to a gas passing through it is proportional to the surface. (It is, of course, assumed that the ordinary conditions of capillary attraction are understood. The mechanical force which draws a fluid *into* a capillary tube acts upon any gas or fluid passing *through* the tube.) Hence, as was observed by Poiseuille, the resistance of the passage of a liquid through a capillary tube is nearly the fourth power of the diameter of the tube. The porous solids possess, no doubt, a similarly reduced penetrability as that possessed by a congeries of capillary tubes. It must, however, be remembered, that the times of diffusion through tubes or pores have no relation to the transpiration of the same gases. Graham has given with much clearness the generally received hypothesis,* which bears so strongly on the final result of this paper, that it is necessary to state it in as few words as possible.

A gas is supposed to consist of solid and perfectly elastic spherical atoms, which move in all directions, and are animated with different degrees of velocity in different gases. Confined in a vessel, the moving particles are constantly impinging against its sides (should we not recognise the influence of the force on the surface of the confining vessel attracting the atoms?), and occasionally against each other. Owing to the perfect elasticity of the atoms, no loss of motion arises from such collisions. If the containing vessel be porous, then gas is projected through the open channels by the atomic motion, and escapes. The external air, or gas, is carried inward in the same manner, and takes the place of the gas which leaves the vessel. The molecular movement is accelerated by heat and retarded by cold; the tension of the gas being increased in the first instance and diminished in the second. This hypothesis assumes that when the same gas is present both within and without the vessel, and therefore in contact on both sides of the porous plate, the movement is sustained without abatement, molecules continuing to enter and leave in equal number, although nothing of the kind is indicated by change of volume. Is it not rather that the force residing on the surfaces of the pores of the septum compels this movement in and out? †

An interesting application of this knowledge has been made by Mr. George F. Ansell, for the purpose of detecting fire-damp in our coal mines. The disastrous consequences arising from the explosions which from time to time occur in working coal,

* See "Mathematical Physics," by John Herapath (1847), and the Memoirs of Bernoulli, Joule, Clausius, and others.

† "On the Law of the Diffusion of Gases" (Transactions of the Royal Society of Edinburgh, vol. xii. p. 222). "On the Motion of Gases" (Phil. Trans. 1846, p. 573). "Capillary Transpiration of Gases" (Phil. Trans. 1846, p. 591; and 1849, p. 349).

renders everyone acquainted with the fact that carburetted hydrogen gas, or rather a mechanical mixture of carburetted hydrogen, nitrogen, and carbonic acid, is constantly escaping, in some mines, from the coal, and that mixing with a certain quantity of atmospheric air becomes fearfully explosive. When a flame, such as that of the Davy safety lamp, is brought into an atmosphere containing fire-damp, its presence is indicated by alterations in the condition of the flame, and the practised eye can determine very readily the presence of the enemy. Sometimes this carburetted hydrogen escapes from the coal suddenly, but generally it escapes gradually from the seam, and, not unfrequently, insidiously increases to a dangerous degree without its being observed. To avoid this, and under all circumstances to indicate the presence of fire-damp, Mr. Ansell avails himself of the knowledge we possess relative to the diffusion of gases. His apparatus takes various forms: the most simple being a thin India-rubber balloon full of atmospheric air, having a ligature of linen bound round its equator to prevent its lateral expansion. This being placed in any part of the mine, it is proposed to connect it by a wire with any ordinary electrical bell at surface. As the balloon expands upwards by the diffusion of the carburetted hydrogen into the air which it contains, it releases a catch, and connection being made by a simple mechanical arrangement with the electrical or magnetic apparatus, the bell is rung. After this signal has been given, the Fire Damp Indicator has only to be removed for a few minutes into good air, and it is restored to its original state. Another form of instrument is that of the aneroid barometer, a porous earthenware plate or a slice of Sicilian marble being substituted for the brass back of the box. This little instrument, which is only of the size of an old-fashioned watch, is carried by the colliery viewer in his waistcoat pocket. At any suspected place it is taken out, and the index gives the barometric pressure at that depth; this is noted; then, if any fire-damp is present, the index moves a certain number of degrees, thus indicating with precision the percentage of carburetted hydrogen present in the air.

This instrument must be regarded as one of the most beautiful of the applications of science. It bears no very remote relation in its principles, to the lamp of Davy itself, and it supplements it in a manner which appears to promise the possible highest utility.*

* It is important to notice here the facts just brought out by a well-devised series of experiments. The safety lamps, of all varieties, are found to be rendered unsafe by the improvements in ventilation. By increasing the velocity of the currents in the levels of a colliery, the explosive atmosphere is driven through the lamp, and the external mixture fired.

The diffusion of liquids into each other is a remarkable expansion of the facts discovered with regard to gases. When two liquids of different densities, and capable of mixing, are placed in contact, diffusion takes place; the rate of diffusion varying with the nature of the liquids, the temperature, and the degree of concentration of the solutions used. The manner in which the experiments are made is exceedingly simple. An open phial is filled with the solution to be experimented on, say the ammonia-sulphate of copper, and a light float placed upon its surface. This is placed in a confectioner's glass jar, and water is steadily poured in so as to cover the open phial to the depth of about an inch. The saline fluid in the bottle is now in contact with the water in the jar, and diffusion proceeds. The ammonia leaves the copper, and the purple solution becomes of a pale blue colour, the volatile alkali being found diffused in the water. The amount of salt diffused, called the *diffusate* or *diffusion product*, is determined by chemical means. Such is the general mode of experiment, and such the character of the results. It is sufficient for the present purpose that the general law is stated. "The velocity with which a soluble salt diffuses from a stronger into a weaker solution is proportioned to the difference of concentration between two contiguous strata." *

Graham has found that bodies may be divided into two classes in relation to diffusion. One class, which are the most diffusive, he terms *crystalloids*. Another class are non-crystallisable, as hydrated silicic acid, hydrated alumina, and metallic oxides of the aluminous class, when they exist in the soluble form. Animal and vegetable extractive, gelatin, starch, gum, &c. are of this order. Gelatin is regarded as the type of these, and from *κόλλη*, *glue*, the term *colloids* is adopted. This peculiar form of aggregation is called the *colloidal condition of matter*, and we find it to be a state required in all the substances which can intervene in the processes of life. Space will not admit, on the present occasion, of that examination of this remarkable class of bodies which is desirable, since they play a highly important part in natural phenomena. The colloidal is regarded as a dynamical state of matter, while the crystalloidal is the statical condition. Colloids are ever in a state of mutation. Metastasis has been well said to be the condition of their existence. So remarkable are the phenomena of colloidal bodies, that those minds which have a materialistic tendency look upon them "as the probable primary source of the force appearing in the phenomena of vitality."

These colloid substances are separated from other bodies by a process called *dialysis*. This will be explained in the fewest

* Phil. Trans. (1862), p. 1. Journ. Chem. Soc. xv. p. 217.

words by describing an experiment. If a sheet of very thin letter-paper, well sized with starch, and having no porosity, be laid on the surface of water, a depression made in its centre, and a mixed solution of cane sugar and gum arabic be poured upon it, the sugar diffuses through the water, while the gum remains above. The vegetable parchment or parchment paper of De la Rue is peculiarly adapted for experiments on *dialysis*.

The passage of liquids through porous septa, which was first studied by Dutrochet, was originally designated by the correlative terms *endosmose* and *exosmose*: in place of which Graham proposes the simpler term *osmose* (from *ὄσμος*, *impulsion*). Osmose has been supposed to be the unequal absorption of the two liquids placed on either side of it by the porous septum. Graham comes to the conclusion that osmose depends essentially on the chemical action of one of the liquids on the septum. The following passage, quoted from Graham's *Elements of Chemistry*, appears to embrace all the points necessary for our present consideration:—

“These experiments were made partly with porous mineral septa, partly with animal membrane. The earthenware osmometer consisted of the porous cylinders employed in voltaic batteries, about five inches in depth, surmounted by a glass tube 0·6 inch in diameter, attached to the mouth of the cylinder by means of a cap of gutta percha. The cylinder was filled to the base of the glass tube with a saline solution, and immediately placed in a jar of distilled water; and as the fluid within the instrument rose during the experiment, water was added to the jar to equalise the pressure. The rise (or fall) of the liquid in the tube was very regular, as observed from hour to hour, and the experiment was generally terminated in five hours. From experiments made on solutions of every variety of soluble substance, it appeared that the rise, or osmose, is quite insignificant with neutral organic substances in general, such as sugar, alcohol, urea, tannin, &c.; so likewise with neutral salts of the earths and ordinary metals, with the chlorides and nitrates of potassium and sodium, and with chloride of mercury. A more sensible but still very moderate osmose is exhibited by hydrochloric, nitric, acetic, sulphurous, citric, and tartaric acids. These are surpassed by the stronger mineral acids, such as sulphuric and phosphoric, and by sulphate of potash, which are again exceeded by salts of potash and soda possessing a decided acid or alkaline reaction, such as binoxalate of potash, phosphate of soda, or the carbonates of potash and soda. The highly osmotic substances were also found to act with most advantage in small proportions, producing, in fact, the largest osmose in the proportion of one quarter per cent. dissolved. The same substances are likewise always chemically active bodies, and

possess affinities which enable them to act on the material of the earthenware septum. Lime and alumina were always found in solution after osmose, and the corrosion of the septum appeared to be a necessary condition of the flow. Septa of other materials, such as pure carbonate of lime, gypsum, compressed charcoal, and tanned sole-leather, although not deficient in porosity, gave no osmose, apparently because they are not chemically acted on by the saline solutions."

Osmose appears to play an important part in the functions of life. In osmose there is also a remarkably direct substitution of one of the great forces of nature by its equivalent in another force, the conversion, namely, of chemical action into mechanical power. Viewed in this light, the osmotic injection of fluids may, perhaps, supply the deficient link which intervenes between chemical decomposition and muscular movement.

There is yet another set of phenomena which, although not generally associated with those which have been considered, appear, upon closer consideration, to be intimately related to them. These are the phenomena of *catalysis*, or contact action. A sheet of perfectly clean platinum being plunged into a mixture of oxygen and hydrogen, compels their union: the action of this metal in a spongy state is well known, and the action of ferments is familiar to all. Each of these are substances which have the power of establishing chemical relations by the action of contact with considerable energy.

We have seen that gases interpenetrate in a very remarkable manner, and that the diffusion of fluids into air, or into each other, exhibits a force sufficiently powerful to break up strong chemical affinities. We have observed the power of porous bodies in compelling the passage through them of gases and fluids; capillarity has been briefly noticed, osmose action described, and contact action slightly indicated.*

We have now to advance a step yet farther, and mention the surprising passage of gases through the homogeneous substance of a plate of fused platinum or of iron at a red heat, the discovery of H. St. Claire Deville and Troost. The porosity of graphite, of earthenware, of marble, and the action of those substances on gases and fluids, may be regarded as fairly understood. A new kind of porosity in metals is imagined, of a greater degree of minuteness than the porosity of graphite and earthenware; this is an intermolecular porosity, due entirely to dilatation. At low temperatures neither platinum nor iron admits any passage of gas; but by the expansive agency of

* In addition, the striking Memoir by Mr. Graham, "On the Absorption and Dialytic Separation of Gases by Colloid Septa" (Phil. Trans. vol. 156, part ii. p. 399), should be studied.

heat the pores are opened, and these metals admit of, encourage indeed, the diffusion of gases. "Such a species of porosity," says Graham, "if it exists, may well be expected to throw a light on the distance of solid molecules at elevated temperatures when gases introduce themselves. The experiments were essentially of the following character. A vacuum was produced in a platinum tube placed within a porcelain tube charged with hydrogen; this tube was raised to a red heat, and the dense metal then became permeable to hydrogen. The same result was obtained with iron.

The passage of a gas through a colloid septum is preceded by a condensation of the gas in the substance of the septum. "Is," asks Mr. Graham, "a plate of ignited platinum capable, then, of condensing and liquefying hydrogen gas?" By an ingenious arrangement the experiment was made, and the result proved that platinum exhibited a new property—the power to absorb hydrogen at a red heat, and to retain that gas at a temperature under redness for an indefinite time. It may be allowable to speak of this phenomenon as a power to occlude (to shut up) hydrogen, and of the result as the occlusion of hydrogen by platinum. Experiments were made with many other metals, and their powers of occlusion carefully determined; that of iron alone can be mentioned in this paper. This was determined by first exhausting iron of any gases held within its pores by exposing it to a high temperature, and then cooling it gradually in hydrogen gas; the metal absorbed and retained this gas after cooling. The iron experimented on was capable of holding 0.46 volume of hydrogen; but when the same specimen of iron was charged with carbonic oxide gas in the same manner, it was found to be capable of taking up at a low red heat and holding when cold 4.15 volumes of carbonic oxide gas. This discovery cannot fail to have a bearing on the important process of steel manufacture.

Pursuing this extraordinary line of enquiry, and obtaining at every step new, confirmatory, and beautiful results, it was resolved to ascertain if the masses of matter obtained from the atmosphere—Meteoric Stones—and which bear evidence of having been at a very high temperature, gave any indication of the kind of atmosphere in which they were formed.

A slice from the meteoric iron of Lenarto, which was analysed by Wehrle, and found to be of sp. gr. 7.79, and to consist of iron 90.883, nickel 8.450, cobalt 0.665, and copper 0.002, was obtained. This was made the subject of careful experiment, and the Lenarto iron yielded 2.85 times its volume of gas, of which 86 per cent. nearly was hydrogen.

"Hydrogen has been recognised," says Mr. Graham, "in the spectrum analysis of the fixed stars, by Messrs. Huggins and

Miller. The same gas constitutes, according to the wide researches of Father Secchi, the principal element of a numerous class of stars, of which *a* Lyræ is the type. The iron of Lenarto has no doubt come from such an atmosphere, in which hydrogen greatly prevailed. *This meteorite may be looked upon as holding within it, and bearing to us, hydrogen of the stars.*

"It has been found difficult on trial to impregnate malleable iron with more than an equal volume of hydrogen, under the pressure of our atmosphere. Now the meteoric iron examined gave up about three times that amount without being fully exhausted. The inference is, therefore, that the meteorite has been extruded from a dense atmosphere of hydrogen gas, for which we must look beyond the light cometary matter floating about within the limits of the solar system."

The series of results which are described in this paper, though differing in their general character, have yet a strict relation to each other. When carefully studied, it will be seen that the sponge and the sugar sucking up water are only modified examples of the dense metals absorbing gases. It is by the cautious questioning of nature, and by closely inspecting the phenomena which are constantly occurring around us, that we advance to a knowledge of sublimer truths. Priestley's observation on the porosity of stoneware tubes, was the germ of that discovery which may without any poetical exaggeration be described as

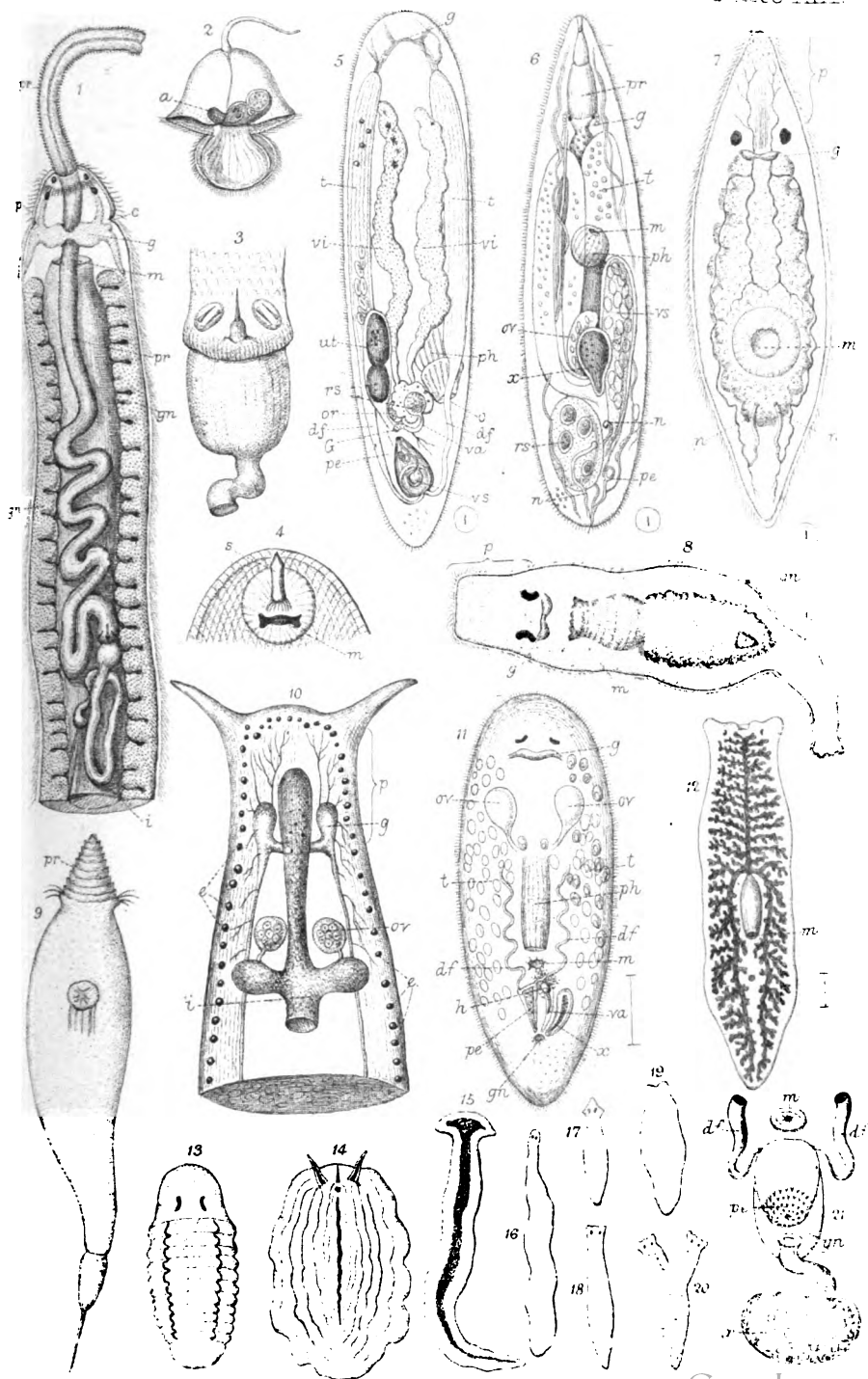
A MESSAGE FROM THE STARS.

ON THE PLANARIÆ OF OUR PONDS AND STREAMS.

By E. RAY LANKESTER.

THE little creatures with the structure and history of which I hope in the following pages to make the reader acquainted, as far as space and the great obscurity surrounding them will permit, belong to a group of animals which is at present perhaps more under discussion among zoologists than any other—a group which stands alone in the anomalous character of some of its organs and methods of reproduction and development, and is remarkable at the same time for the many points of resemblance presented by it to several other large zoological groups. The great sub-kingdom Vermes or Annuloida is now generally recognised as embracing five large but subordinate classes of worm-like animals, characterised by their general elongate and frequently jointed form; by the absence of jointed locomotive organs, the place of which is frequently supplied by suckers, or by soft processes bearing movable bristles; by the very abundant distribution of cilia on the surfaces of their bodies, or of their internal organs, at one or other period of life; by the correlated, unstriped, or faintly-banded character of their muscular fibre; by the primarily ventral position of their mouths; by the absence or terminal position of the anus; and by the presence of a peculiar vascular system (the water-vascular system), sometimes closed, but frequently communicating with the exterior, the fluid in which performs in part the functions of the blood of higher animals, and in many cases contains the same colouring matter as the red blood-corpuscles of man. They nearly all exhibit remarkable metamorphoses in growth, and reproduce by gemmation and fission as well as sexually; many are internally parasitic.

Of these five classes, the most highly organised is the group of Ringed Worms or Annulata, comprising the marine, freshwater, and terrestrial bristle-bearing Worms, and the Leeches. The class of Wheel-animalcules (Rotifera) is by some excluded from the Vermes, but seems to fall naturally within the limits of the sub-kingdom, connecting it with the Crustacea; other zoologists



would include the remarkable animal *Sagitta*, which is, however, a transition form. The *Sipunculi* (Gephyrea) connect Vermes with Echinoderms. The Round-worms (Nematelminthes, comprising the parasitic *Ascaris*, *Gordius*, and *Echinorhynchus*) and the Flat-worms (Platyelminthes, embracing the Turbellaria, Fluke-worms, and Tape-worms) complete the list, unless we include the Echinodermata, which are by the latest writers regarded as forming a separate sub-kingdom of equal rank with Vermes.* It is to the class Platyelminthes, and the order Turbellaria, that the Planarians belong, forming one of the two sections into which that order is now divided. Having, from the above brief enumeration of the groups forming the sub-kingdom of Worms, seen what are the animals which are held to be most akin to those we are about to study, we may descend a step (or rather two steps) lower, and examine the order Turbellaria, and then select one or two individuals of the Planarian section. Before doing so, however, I must draw the reader's

* A TABULAR VIEW OF THE CLASSES AND ORDERS OF VERMES.

Sub-kingdom: *Vermes*.

CLASS I.	<i>Annulata</i> (Ringed-worms)	
	Orders: <i>Polychæta</i> (Marine)	
	<i>Oligochæta</i> (Land and Fresh-water)	
	<i>Discophora</i> (Leeches)	
„ II.	<i>Gephyrea</i> (connected through the Sea-cucumbers to Echinodermata)	
	Orders: <i>Sipunculus</i> , &c.	
„ III.	<i>Rotifera</i> (connected to Arthropods and Turbellaria)	
	Orders: <i>Cephalotricha</i> (Wheel-animals)	
	<i>Gastro-tricha</i> (Hairy-backed animals, Chætonotus)	
„ IV.	<i>Nematelminthes</i> (Round-worms)	
	Orders: <i>Nematodes</i> (Thread-worms, Vinegar-eels, &c.)	
	<i>Gordiacea</i> (Hair-worms)	
	<i>Acanthocephali</i> (Echinorhynchus)	
„ V.	<i>Platyelminthes</i> (Flat-worms)	
	Orders: <i>Turbellaria</i> (Planarians and Nemertians)	
	<i>Trematodes</i> (Flukes, King's Yellow-worms)	
	<i>Cestodes</i> (Tape-worms)	

Order: *Turbellaria*.

SECT. A.	<i>Proctucha</i> (Nemertians)	{ With a proboscis . . . <i>Rhynchocæ</i>
		{ Without a proboscis . . . <i>Arhynchia</i> li
		{ With a straight intestine, and generally a proboscis . . . <i>Rhabdocæla</i>
„ B.	<i>Aprocta</i> (Planarians)	{ With an arborescent intestine, and no proboscis, but an expanded frontlet . . . <i>Dendrocæla</i>

There is a growing opinion amongst zoologists that the majority of the Infusoria may be classed among Vermes near the Turbellaria. Might not the Gregarinida also be associated with the Helminthes?

attention to the fact that there is *nothing* written in the English language on these worms which will give him any fair notion of their structure, or in any way help him to study their generic and specific differences. The statements in handbooks of zoology are, when correct, too wide and general to be of much service, and recourse must be had to the German writings of Oscar Schmidt and Max Schultze, and to the French memoirs by Van Beneden, Claparède, and De Quatrefages. I have appended a list of some of these works. The British Museum Catalogue of Worms, which professes to give some account of the Turbellaria, is *most incorrect*, and quite useless in relation to them.

The Turbellarians are very soft, flattened animals, very long or short, and oval in shape, with their mouths placed ventrally, leaving a large *præoral region* (prostomium of Annelids).^{*} Their internal organs, like those of the other Flat-worms, are *closely packed* together and embedded in their muscular body-walls, leaving no free space such as what, in Annelids, is called "a perivisceral cavity;" like the other Flat-worms, they never have the outline of their bodies broken by the development of lateral *projecting flaps* to be used as feet or paddles; and like them, their growth and development from the egg is complicated by very strange metamorphoses, and by the so-called "alternation of generations." They agree with them further, though less strikingly, in the fact that the yolk which surrounds the egg, and on which the young animal is to feed, is in many cases secreted by a distinct wide-spreading gland called the "*vitellarium*;" and like certain of the Flukes (Trematoda) they have a tendency to develop regularly-shaped hard *stylets* or "thorns" in connection with both their *præ-oral region* (proboscis) and their

* This *præoral region* is an important feature in Turbellarians, and, indeed, in most Vermes, forming the "Kopf-lappen" or prostomium in Annelids, which may be so elaborately modified into a head with appendages. In Turbellaria, the term "præ-ganglionic region" would be more truthful, since the position of the oral opening of the alimentary canal varies, though it is, probably, always in the *post-ganglionic* region. I say probably, for certainty is very hard to obtain. The proboscis was so long thought to carry the mouth, that the true postganglionic aperture has been overlooked; and this may even yet prove to be the case with the genus *Acmostomum*, observed by both Schmarda and Mecznirow. The large-paired ganglia, I believe, invariably mark off an anterior region carrying the eyes, and a posterior carrying the mouth. This anterior region may be variously modified into an expanded frontlet (*Planaria*), or a jointed and spine-bearing proboscis (*Nemertians*, *Alaurina*, and *Prostomium*). This view is taken by Professor Rolleston, and has much in its favour. But even since writing the above, my friend Dr. McIntosh, who is preparing a work on Turbellaria for the Ray Society, tells me that everybody is wrong about the mouth in Nemertians—that the postganglionic orifice exists in a few genera only—and hence the above homological views will be upset!

generative organs (Pl. XIX. figs. 3, 4, 6 *pe*). They differ notably from both the Trematode and Cestode Flat-worms in the complete and permanent *ciliation* of the surface of their bodies, which is one of their most characteristic features; also in having *no sucking discs or prehensile hooks*, such as both these other orders possess, used for locomotion and adhesion, but only a *sucker-like mouth*. In their mode of life they present the most striking contrast to both Trematodes and Cestodes; for whilst the members of these orders are one and all parasitic (chiefly internally), no Turbellarians are ever so, though they are found in the sea, in ponds, and fresh-water streams, and in moist earth and decaying wood. The *integument* of the Turbellaria is remarkable not only as being densely covered with cilia, but as containing very numerous oblong corpuscles and clear cells, some of which have been compared to the "nettle-cells" possessed by the Polyps, jelly-fish, and Nudibranchiate Molluscs. The *muscular fibre* is not separate or collected into masses apart from the skin and viscera, is in some cases faintly striated transversely, and presents, with the rest of the worm's organs, a most singular softness and fluidity; so that while living most Turbellarians are almost incredibly elastic, and when dead decompose and become a watery mass in the course of one or two minutes. The *digestive organs* are very simple: the sucker-like mouth, placed in almost any position (except terminally) on the ventral aspect of the body—towards the front, centrally, or quite posteriorly—opens into a pharynx, which is very frequently muscular and eversible; from this a straight or arborescent cavity extends throughout the body, opening in an obscure terminal anus in the Nemertines, but having no outlet in the Planarians. Little glandular masses, assisting by their secretion in digestion, surround the digestive tract; and by Leydig are said to act as kidneys also. In both Nemertians and Planarians the region in front of the mouth is often (but not always) modified to form what is called the proboscis, a most extraordinary organ, which has caused the greatest differences of opinion, and has prevented and does still prevent the proper understanding of the anatomy of these animals. The real mouth varies so much in its position, and is often so very backwardly placed (especially in the Planarians), that for a long time it was thought to be a sucker like those of the Fluke-worms, and the proboscis being in front was thought to carry the true mouth. It is now admitted by Schmidt and Schultze (though themselves at one time mistaken) that no Turbellaria have any sucking discs; and that the proboscis is quite separate from the mouth, though it may be perforated in some cases. It is probably in most cases a prehensile appendage, but its use is very obscure. Suppose you have a Turbellarian as I have described—with ventrally

placed mouth, an alimentary canal, and a large flat expanse of body (always carrying the eyes) in front of the mouth—to form the proboscis, you must draw out this præoral region to a length sometimes equal to that of the whole animal, arm it in some cases with stylets or spines, and tuck the muscular tube thus formed into the body, making it overlie the alimentary canal, as the finger of a glove might be tucked into its hand. Thus you may conceive the “proboscis” of Turbellarians to be formed, with muscles so that it can be drawn in and out at pleasure. Its doubtful use has caused various mistakes. Many have not got it, but only an expanded or simpler modification of the præoral region (Dendrocoel Planarians); all the Nemertians, however, are thus armed, and many of the Rhabdocoel Planarians. De Quatrefages regarded the proboscis of Nemertians as the alimentary canal, no doubt reminded by it of the eversible pharynx which the marine Annelids possess. Oersted took it for the main organ of copulation, led into this error by the frequent presence of little hard spines, which are also found in the penis of some Turbellaria (Opisthomum). Leuckart was one of the first to recognise the presence of the proboscis in the straight-gutted Planariæ, in which most of all there had been a confusion with the mouth (even till within the last three or four years), and now the latest and most reliable writers (e.g. Victor Carus) are of his opinion.

The *nervous system* of Turbellarians is very simple; it consists essentially of two large ganglia placed in front (often *very far* in front) of the mouth, and joined by a short sort of commissure, which passes always over the dorsal surface of the proboscis when it is present. Twigs pass in various directions from these ganglia, two principal lateral stems being often present. There is no representative of the cord and ganglia placed beneath the alimentary canal which is found in Annelids and Arthropods. The *eyes*, which are very simple, often only pigment spots, vary in number from two to sixteen or more; and being always close to the great ganglia (the equivalents of the sensory or supra-oesophageal ganglia of higher animals), are always in front of the mouth. In some Turbellarians a supposed auditory capsule is present, and the Nemertians are peculiar in possessing two ciliated clefts in the præoral region, which may be sensory. The *vascular system* is closed in adult Nemertians, and contains red blood in some species; in Planarians, its stems, which are disposed laterally, communicate by two or more contractile apertures with the exterior, and water is thus admitted.

We have now to speak of the generative organs and methods of reproduction and development in these creatures; and here a word may be said as to the strange and anomalous position of the mouth in relation to the fore and hind extremities, and the

shapeless ovoid form of many Planarian species. They are instances of what is called "retrograde development;"* and we must not look at the modified shape and disposition of parts in the adult, so much as at the history and early condition of those parts, if we wish to see what are the true relations of the animal. The resemblance between Nudibranchs and Planarians is, when thus examined, found to be more apparent than real; both live under the same conditions, beneath rocks and stones in the water, and exhibit identical modifications, but of very different types. They agree chiefly in their ramified intestine, flattened form, and nettle-cells in the skin. The relation to the Infusoria and to the Hairy-backed Animalcules (*Chætonoti*) is a much truer one. Copious cilia, occasional stiff hairs, nematophores or trichocysts, pulsating water-vessels, and parenchymatous viscera are important characters met with in all three, while no corresponding differentiating characters exist. The young larval forms of some Turbellaria very closely resemble Infusoria and *Chætonoti* too, whilst they approach the Annelid type as well. Turbellaria are either bisexual, or alternately male and female, or hermaphrodite. The Nemertians are believed all to be bisexual, whilst no Planarians are known to be permanently so. The female organs are an ovary, a vitellarium, a receptaculum seminis, and a uterus: the male organs are testes, vesiculæ seminales, a duct and penis, armed sometimes with a style. In the Nemertians, which are bisexual, only the essential organs are developed; it is in the hermaphrodite species (Planarians) that here as elsewhere the most complex development of organs is found, of which we shall see more hereafter.

The Turbellarians propagate either by eggs deposited and fertilised in the water, several eggs being often deposited in one mass of yelk (like what was observed by Dr. Carpenter in the Dog-Whelk), or by the growth of young from internal buds or pseud-ova, like the larvæ of *Cecidomya*, or by transverse fission. Both Nemertians and Planarians exhibit these three methods. The young either develop directly, becoming similar to their parents at once; or they exhibit a jointed ringed structure (like Annelids), sometimes too carrying bristles, as has been lately shown by Mr. Alexander Agassiz, both in Planarians and Nemertians, and then, as they grow older, lose their jointed appearance and setæ; or the egg-hatching results in a larva (*Pilidium*) which is totally unlike the parent, and from the body-wall of which a small worm-like animal grows and separates, leaving the bulk of the *Pilidium* to perish (fig. 2). This last case is very similar to that observed by Johannes Müller in certain star-fishes. As in the Echinoderms, so in the Turbellarians there appears to be

* The Cirripedes, Lernæans, and Linguatuli are similar instances.

no *rule* as to the method of development; nearly allied forms may present the most diverse conditions, the one passing through a larval stage, and the other developing directly in the most capricious manner (figs. 9, 13).

And now that we have reviewed the group of Turbellarians generally, we have to speak of one of its two divisions. Leaving for a future period the long, almost snake-like Nemertians, we pass to the small flattened Planarians, and have to attempt to make some of their commonest fresh-water forms known. The Planarians or Aprocious (without an anus) Turbellarians are found on the sea-shore, in fresh waters, and in the earth. The marine species of our own coasts are not abundant, but occur on most rocky shores. *Some* of the fresh-water species occur in almost every pond and ditch, whilst one earth-living species is known in Europe, and may be expected to occur in Britain. It is quite impossible to give a list or descriptions of the British species, as no one knows how many there are, so little attention has been paid to them. I think, however, a diagnosis of the genera which may be *expected* to occur in ponds or streams, will be useful, and a brief description of one or two fresh-water species, which, though much smaller and far less brilliantly coloured * than the marine forms, are more readily accessible. After examining these, the reader will be able readily to trace the anatomy of others for himself. On account of the homologies of the proboscis, mouth, and præganglionic region in Planarians, at present so greatly needing further investigation, the genera as they now stand are in many cases based upon error. Even in Victor Carus' *Handbuch der Zoologie* (1863), I find the confusion of mouth and proboscis maintained in the generic names, though in the chapter on anatomy it is renounced. The value of the "proboscis" as a classificatory character is rendered doubtful by the fact that when absent or rudimentary in the adult, it may be present in the young state. Dugés and Oscar Schmidt have both made generic names intended to indicate the position of the mouth, but the *meaning* of these names must now be disregarded. For the determination of *species*, the reader must do the best he can with the papers of Dugés and Schmidt; they are by no means definite, and anyone who will devote a few years to the study of our British species will do valuable work.

* Some fresh-water forms were stated by Max Schultze to contain chlorophyl as a colouring matter, as also Hydra and Stentor. This I have lately verified by spectrum-analysis.

PLANARIANS, OR TURBELLARIA APROCTA.

Intestine without a posterior opening.—Hermaphrodite.

SECT. A.—*Rhabdocæla*. Intestine a straight sac. Usually two eyes on the ganglia. Body generally of an elongate oval form.

(α) *With a muscular pharynx, usually exertile.*

- Genus 1. Præganglionic region in the form of a conical muscular proboscis. Mouth circular.—PROSTOMUM, Dugés (*Rhynchoprobolus*, *Acmostomum*, Schmarda).
- „ 2. Præganglionic region well developed, broad and blunt. Pharynx tub-shaped.—VORTEX, Ehr. (*Derostomum* of Dugés).
- „ 3. Præganglionic region not muscular, and reduced in size. Mouth circular, near the centre of the body.—MESOSTOMUM, Dugés (*Strongylostomum Typhloplana* of Oersted).
- „ 4. Præganglionic region small. One eye. Body long and worm-like. Mouth central. (Marine.)—MONOCELIS, Oerst.
- „ 5. Præganglionic region reduced to a minimum. No eyes. Mouth towards the posterior end of the body.—OPISTOMUM, O. Schm.

(β) *A muscular pharynx is wanting.*

- „ 6. Mouth an oval opening, placed lengthwise near the fore end. Præganglionic region small and flat.—MACROSTOMUM, Oerst.
- „ 7. As the last, but mouth a long slit.—ORTHOSTOMUM, O. Schm.
- „ 8. Mouth a cross slit. No eyes. (Marine.)—CONVOLUTA, Oerst.
- „ 9. Præganglionic region pinched off as a kind of head, carrying two tentacular processes. Mouth round, behind the eyes.—VORTICEBOS, O. Schm.

SECT. B.—*Dendroccæla*. Intestine an arborescent or multiramose cavity. Eyes often numerous. Præganglionic region broad and flat, often tentacular, forming a frontlet. Body flat, broad.

(α) *Digonopora*. With double genital openings. All marine; often brilliantly coloured.

(β) *Monogonopora*. With a single genital opening. Nearly all fresh-water or terrestrial. All with a large muscular pharynx.

- Genus 1. Body oblong, flat. Mouth subcentral. Frontlet* three-cornered, or with tentacle-like corners. Eyes two, with lenses.—PLANARIA (*Dendroccelum*).
- „ 2. Frontlet small. Eyes many. The rest as Planaria.—POLYCELIS, Ehr. (not De Quatrefages).
- „ 3. Body elongate and vermiform, often brilliantly coloured. Præganglionic region (frontlet) large and broad, sometimes expanded as a hammer-head. Animals all terrestrial.—GEOPLANA.

This synopsis of genera is no doubt in many ways imperfect, but I believe it gives a fair view of the principal divisions of the fresh-water forms. The Rhabdocæls are minute, and abound

* This name is proposed by Professor Rolleston for the præganglionic region of *Dendroccæla*.

in most ponds and streamlets. They are best observed first with a lens—in a bottle of the water containing them, and then afterwards picked up in a tube drawn out to a fine opening. The commonest forms belong to the genera *Mesostomum*, *Vortex*, and *Prostomum* (figs. 5, 6, 7, 8). The species are at present quite undefined.

The marine *Dendrocoels* I have omitted. They are very beautiful in colour and graceful in form—many species are figured in the memoirs by De Quatrefages and Claparède (fig. 14). The commonest little black fresh-water *Planaria* belongs to the genus *Polycelis*, having many eyes; species of true *Planaria* are, however, abundant enough with them (figs. 17, 18). All these *Dendrocoels* are much larger than the *Rhabdocel* forms, being often more than half an inch in length, and very conspicuous by their dark colours. Dugés, in his memoirs (1828-1830), describes several species, and also the wonderful power of reparation of injuries they possess. By slicing them with scissors, individuals may be produced with two heads or two tails, and otherwise modified. It is Oscar Schmidt, however, who within the last seven years has described their anatomy.

Dugés found the very remarkable *Geoplana terrestris* (fig. 16) in France in Languedoc, and it ought to occur in England. Will the readers of the *Popular Science Review* hunt it out?

I now propose to speak of the anatomy of *Opisthomum*, a *Rhabdocel*, and *Polycelis*, a *Dendrocel*, in greater detail.

Having caught sight of an *Opisthomum* (fig. 5) or *Mesostomum* (fig. 7) swimming over the surface of a bottle of pond-water, you may conveniently catch the minute creature by making use of a dipping tube with a fine orifice, and then place it on a compressorium or under a glass cover. The first thing to note is the ciliation of the whole surface of the body, excepting the sucker-like mouth, which in *Opisthomum* will be readily seen lying very far back near the posterior extremity (fig. 6). A little closer examination of the clear transparent skin will disclose the presence of very numerous clear oblong corpuscles, which are scattered all over it, and belong to that group of organs which is represented by the "trichocysts" * of Infusoria and the nettle-cells of Polyps and other animals.

Examining now the digestive organs, it is not difficult to trace the large cylindrical and muscular pharynx (*ph*) opening from the mouth and leading into a capacious but simple sac which has no other opening—this is the stomach and intestine both. Coloured granular masses are crowded on its surface, and some of these, perhaps, act as a sort of bile-forming organ. Overlying this stomach are other masses of cells and muscular fibres, of the

* See Allman, Jour. Micros. Sci. (1855), vol. iii. p. 177.

simplest form, which form a body-wall of unlimited powers of movement. The large accumulations of cellular masses belong to the generative system, and may often obscure other parts. Quite in front is the pair of nervous ganglia (*g*) which send out their minute and invisible branches in all directions. In *Opisthomum* there are no eyes to guide one in finding the ganglia, and hence the task is not so easy as in *Mesostomum*, *Prostomum*, and *Vortex* (figs. 7, 6, 8), in which the eyes lie just in front of the ganglia; nor is there any expanse in front of the ganglia—the “proganglionic region” is reduced to the smallest amount. Winding in and out among the contents of the body, sending out branches here and there, you will observe two indistinct tubes, running lengthwise, one on each side of the body (*nn*). These vessels are the main stems of the water-vascular system, and may be traced to two pores or openings placed far back on the ventral surface. Their internal surface is ciliated, but they are not contractile.

The reproductive organs are the most curious and most important points to make out in the straight-gutted Planarians; and, indeed, in the Dendrocoels also they have been used as specific and generic characters. Although hermaphrodite, *Opisthomum*, like other Rhabdocoels, has only one outlet for the ova and the seed. The Dendrocoel Planarians are well divided into two groups, according as the generative opening is single or double (a male and female); and Elias Mecznirow* thinks that this may some day be done with the Rhabdocoels. The testes (fig. 5 *t, t*) in *Opisthomum* form a large sac on each side of the body, opening into a middle seminal vesicle placed quite posteriorly; leading from this is the very long coiled penis, which is covered with spines. In *Prostomum* (fig. 6 *pe*) there are in this position large and hard stylets, like the “dart” of the common snail, which some writers have considered as belonging to the male generative apparatus, and others have regarded as stinging organs. The ovaries (*ov*) are seen nearer the genital pore than the testes, and are smaller bodies; they open into a cavity (*ut*) which has been called the uterus; into this also open two large glandular masses (*vi*) called “vitellaria,” which in most animals form part of the ovary, but are here separated as distinct glands, as in many molluscs. They secrete the greater mass of the yelk, or food-yelk, as opposed to the essential formative part of the ovum, which is developed in the ovary; just as in birds the food-yelk is secreted by the Graafian follicle. Besides these two glands, a cavity which receives the sperm during copulation (*rs*) opens into the uterus, and it is by this means that in the uterus the contact of the ova and spermatozoa is effected. The

* Wiegmann's Archiv, 1865.

uterus itself communicates with the exterior by the same open cavity or pore as does the penis. This pore is much larger and more important in the Dendrocoels than in *Opisthomum* and its allies. The exact anatomy of the uterus and its connected glands is still doubtful, according to Mecznirow, although most carefully investigated by Schultze. The reader, perhaps, may be induced to try to place it beyond a doubt.

We pass on now to *Polycelis*. It is to this genus of the Planarians with *tree-like* intestines, that our common little black Planaria (*Polycelis nigra*) belongs; other dark-brown and blackish species are not uncommon about the same size or a little larger (to the third of an inch), and belong, some to the genus *Planaria*, some to the genus *Polycelis* as defined above, and are distinguished to a great extent by the shape of their frontlets. Some species (*Pl. lactea*, &c.) are to be got which are quite white and clear, and are admirably adapted for study.

The same ciliation of the surface, and the same, though more elaborate, corpuscles in the skin, are to be noticed in *Polycelis* as in *Opisthomum*. The subcutaneous muscular system has even a more extraordinary development, for the animals *flow* or slip over a surface more like a liquid drop on a piece of glass than living creatures. The mouth (fig. 12) in our figure of the digestive organs of *Planaria lactea* is, as in *Polycelis*, near the centre, and leads into a large, exsertile, suctorial pharynx; this, according to the observations of Dugés, the animal protrudes, and firmly fixes to small worms, insects, larvæ, or whatever may be its prey, and through it sucks their juices. The beautifully dendroid character of the intestine is well seen in the figure. The nervous system, which in fig. 10 is illustrated by that of *Polycelis cornuta*, is similar to that of Rhabdocoels, but its branches are more obvious. The water-vascular stems are obscure, but Max Schultze says he has seen them in *Pl. torva*, and so we may expect them in *Polycelis*. The generative organs are highly developed in *Polycelis* and its allies. In fig. 21, the penis, uterus, and ends of the sperm-ducts of *Polycelis nigra* are drawn. The penis is covered with spines, and varies curiously in shape in different forms. In fig. 11, the genitalia and pharynx of *Planaria torva* are drawn according to Schultze. *Polycelis* differs from this only in one important matter, and that is the absence of the little gland or supposed spermatophore (*h*). As in Rhabdocoels, we have vitellaria, ovaries, and a uterus, spermatheca, testes, seminal vesicles, and a penis, as also a very large cavity or vestibule into which they all open. Oscar Schmidt has written some very beautiful papers on these organs in *Planaria* and *Polycelis* (*Zeitsch. für Wiss. Zool.* bd. x. xi.), and has shown how their arrangement differs in different species.

Schmidt has also in *Pl. cornuta* described what he says may be spinarets, like those of a spider, but he doubts about them. I think it important to mention that Dalyell, in his "Power of the Creator," notices two or three species of Planarians as apparently spinning and hanging by threads.

And now, before ending, I may urge those who can, to study and draw carefully any Planarians they may find, as material is greatly needed for a complete history of Fresh-water Planariæ. The ponds on Hampstead Heath and the wonderful old pond at the Surrey Gardens (St. Thomas's Hospital) I have found to be excellent hunting grounds.

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DESCRIPTION OF PLATE XIX.

- FIG. 1. Diagram of the anterior half of a Nemertian worm: *pr*, proboscis; *p*, præganglionic region; *c*, ciliated cleft; *g*, nerve ganglion; *m*, ventrally-placed mouth; *gn*, generative gland; *i*, intestinal canal. Five times the natural size.
- " 2. *Pilidium gyrans*: *a*, rudiment of young Nemertid. Greatly magnified.
- " 3. Style-apparatus of the proboscis of a Nemertian.
- " 4. Anterior part of a *Cercaria* (from the *Lymnæus stagnalis*), to show the striped integument. The mouth *m*, and the stylet *s*, placed in the præoral or præganglionic region.
- " 5. *Opisthomum pallidum*, Schmidt (copied from Schultze): *g*, nerve ganglion; *o*, mouth; *ph*, pharynx; *tt*, testes; *df*, vasa deferentia; *vs*, seminal vesicle; *pe*, penis; *G*, genital opening; *va*, vagina; *rs*, receptacle of semen; *or*, ovary; *vi*, yolk gland; *ut*, uterus, with two eggs.
- " 6. *Prostomum lineare*, Ehr. (after Schultze): *pr*, proboscis; *g*, nerve ganglion; *m*, mouth; *ph*, pharynx; *t*, testes; *vi*, yolk gland; *vs*, vesicle for semen; *pe*, penis (with a hard dart); *rs*, receptacle of semen; *ov*, ovary; *x*, uterus (according to Mecznikow); *n n*, water-vessels and their openings.

- FIG. 7. *Mesostomum* *sp.*, observed at Hampstead : *p*, præganglionic region, showing a tendency to become muscular and probosciform ; *g*, nerve ganglion ; *m*, mouth ; *nn*, water-vessels.
- „ 8. *Vortex* (of Schmidt) *sp.*, observed at Hampstead : *g*, nerve ganglion ; *m*, mouth ; *gn*, genital orifice.
- „ 9. Microscopic larva of a marine Turbellarian (*Alaurina*), observed by Claparède.
- „ 10. Anterior portion of *Polycelis cornuta*, after Oscar Schmidt : *p*, præganglionic region ; *g*, nerve ganglion ; *ov*, ovary ; *i*, part of the ramifying intestine ; *ee*, eyes.
- „ 11. *Planaria torva* (Müller) : *g*, nerve ganglion ; *m*, mouth ; *ph*, pharynx ; *ov*, ovaries ; *tt*, testes ; *df*, efferent ducts ; *pe*, penis ; *h*, supposed spermatophore ; *x*, uterus (?) ; *va*, vagina ; *gn*, genital opening.
- „ 12. *Planaria lactea*, showing the Dendrocoel character of the intestine : *m*, mouth.
- „ 13. Microscopic larva of a marine Dendrocoel Planarian, after Alexander Agassiz.
- „ 14. *Eurylepta vittata*, a marine Dendrocoel ; nat. size.
- „ 15. *Bipalium*, an earth-planarian from Ceylon ; nat. size.
- „ 16. *Geoplana terrestris*, after Dugés ; nat. size.
- „ 17. *Planaria gonocephala*, after Dugés ; nat. size.
- „ 18. *Planaria tremellaris*, after Dugés ; nat. size.
- „ 19. *Planaria caeca*, after Dugés ; nat. size.
- „ 20. *Planaria* cut so as to produce two heads, after Dugés.
- „ 21. Part of the genitalia of *Polycelis nigra* : *m*, mouth ; *df*, seminal efferent ducts ; *pe*, penis, with prickles ; *gn*, genital vestibule ; *x*, supposed uterus (see fig. 11).

VENTILATION AND VENTILATORS.

By THE EDITOR.



IF we may be permitted to define cant as the current expression of unintentional insincerity, we believe that there is no species of cant more general than that which people talk about ventilation. Go where we may, whether into the houses of the wealthy or into the miserable dwellings of the poor, we hear the same cry about ventilation and its advantages; but in no cases, or at least in few, do we see any reason to think the cry a genuine one. How many people tell us of the healthy influence of pure fresh air, but how few ever take proper steps to introduce it into their houses! How seldom do we see anything like a rational system of ventilation in public buildings; and where are the private dwellings in which vitiated breathing-air is not abundantly present? It is not our intention, in the observations we are about to make, to dwell upon the elementary facts that human beings contaminate air by the exhalations from their lungs, and that the respiration of such air is eminently injurious to health. These have already been fully and forcibly pointed out by Dr. Edwin Lankester.* Indeed, we think it is now pretty generally admitted that the influence of a greater proportion of carbonic acid in a breathing atmosphere than that of .6 per 1000 is both adverse to comfort and obnoxious to health. We purpose, therefore, to lay before our readers, as clearly and withal as briefly as possible, the principles on which ventilation should be conducted, and to describe the more important methods by which such thorough ventilation as can be adopted may be achieved.

At the outset we may state, in very general terms, that the word ventilation simply expresses the passage in and out of air. The regulation of this inlet and outlet, in such a manner as to be least productive of discomfort and disease, is one of the highest aims of hygiene. We may add, too, that it is by far its most difficult problem. In an ordinary room it is clear that air is constantly entering and leaving by some of the apertures in

* See *Popular Science Review*, vol. iii. p. 8.

the doors and windows, and through the chimneys. This may be easily proved, experimentally, by holding a lighted taper near any of these points. But it is equally true *à priori*. It happens generally that the inlet is not sufficient to remove the carbonic acid rapidly enough to reduce its proportions to the standard above given. The question then arises, How are the conditions necessary for the production of this standard ascertained? This is exactly what we propose to discuss, for it supplies the key to the whole principle of ventilation. There is the less difficulty in popularising this subject, that of late it has received the studious attention of some of our ablest chemists and sanitarians, who have laid their opinions before the public.* Before, however, we plunge *in medias res* of ventilation, we must ask the reader to remember that the physical law known as that of "mutual diffusion," plays an important part in all questions relating to the mixture of different gases, such as of oxygen, nitrogen, and carbonic acid, which make up our atmosphere. By virtue of this law, it occurs that two gases when brought together, no matter what their relative weights, become thoroughly mixed together, in proportions which are stated as being inversely as the square roots of their densities. Carbonic acid is a gas so heavy that it may be decanted from one vessel into another; and hydrogen is so light that a balloon filled with it ascends, as we all know, into the air. Yet if a vessel filled with the latter be inverted over one containing the former, and a piece of membrane be placed between the mouths of the two, it will be found that, after a while, some of the carbonic acid has ascended into the upper vessel, and the hydrogen has descended into the lower one, and mingled with the carbonic acid. A mixture will be thus formed in both vessels. It is the same in nature. Animals are perpetually exhaling carbonic acid into the atmosphere, and were it not for this wonderful property of "diffusion," a stratum of foul air would lie over the earth, and would possibly extinguish animal existence. This, then, is one of the great facts of ventilation, as it is in nature. There is, however, another point in which natural ventilation is superior to all other forms—viz., that plants use up the carbonic acid as food, setting free the oxygen which helped to form it, and thus, as it were, manufacturing air for the use of animals. The law of diffusion the reader must consider as the starting-point in all ventilation problems. With this law as his guide, he is prepared for the consideration

* See Papers by Dr. A. Smith, F.R.S., Dr. E. Smith, F.R.S., Professor Donkin, F.R.S., and Dr. Parkes, F.R.S., in the "Report of the Committee appointed to consider the Cubic Space of Metropolitan Workhouses." Presented to both Houses of Parliament, 1867.

of the other principles of this branch of hygiene. Concerning the extent of its operation, however, the student encounters his first difficulty, for it must be confessed that all writers are not agreed as to whether, in the case of the atmosphere of dwelling-rooms, the diffusion which takes place is complete or partial. Decision in regard to this is "a consummation most devoutly to be desired," for in its absence we are driven to accept one of two alternatives. For instance, it being known how much air one individual vitiates per minute in breathing, if it were admitted that complete diffusion occurs, we could calculate with tolerable precision what quantity of fresh air should be introduced per minute into a room of known capacity, in order to enable healthy respiration to take place. But if we admit that the diffusion is only partial, and that atmospheric currents may sweep away the foul air as it issues from the lungs, and before it has had time to mingle *thoroughly* with the air of the chamber, then our basis of calculation is so uncertain and variable that nothing short of practical demonstration can give us a clue to the quantity of air which it is necessary to supply for the purposes of health. These may not at first sight appear serious objections, but it must be borne in mind that the end of all efficient ventilation is the removal of exactly so much vitiated air as will leave the remaining atmosphere fit for healthy respiration, and no more than this, and the achievement of this without inconvenience or discomfort. It follows, then, that if any system of ventilation be based on erroneous calculation, either too much or too little air will be introduced into the apartment ventilated, and thus the inmates will either be supplied with impure air or be exposed to unpleasant draughts. The necessity for the establishment of a rigid elementary principle, as the starting-point of all systems of ventilation, is therefore obvious.

It may be as well, before going further into the subject, to lay before the reader the views of two able writers, whose opinions are somewhat materially in conflict. Dr. Angus Smith and Dr. Parkes, of Netley, have both devoted much time and skill to the investigation of the conditions of ventilation, but they come to very different conclusions as to the question, Can a small room be more thoroughly ventilated with a given supply of air than a large one? Dr. Smith advocates the employment of the small room under the circumstances referred to. He says: "Let us imagine a man in a small box, or having his head in a small box, in which he would be supplied with air sufficient for an inhalation as often as he required it. The total amount would be about 12 to 20 cubic feet in an hour. The stream of air is so rapid that the impure is removed as rapidly as the pure is supplied. Put the same man in the

space of 500 cubic feet of air, and supply him with the same amount of air as he received in the small box, and it becomes rapidly noxious. We see, then, that the mode of supplying the air is one of the most important points. *In a very small space a man may find a very little air to be enough by rapid ventilation. In a considerable space a man may find himself uncomfortable from the want of ventilation, even although the amount of air supplied by ventilation is many times greater than in the small space.*" No further quotation is necessary to show the nature of Dr. Smith's views. The writer evidently believes that in small spaces the heated air from the lungs ascends from the mouth, and is borne away by currents before it has had time to mingle intimately with the air of the chamber. This is, in fact, nothing less than a denial that thorough diffusion takes place. To accept Dr. Smith's views, we must admit a partial diffusion only, and we fancy that the author's system must admit draughts. Let us see, then, what Dr. Parkes has got to say in reply, for we could not state the argument against Dr. Smith in a more concise or intelligible form than it has been expressed by the distinguished Professor of Hygiene in the Army Medical School. Dr. Parkes first points out that the man in the box must not be supposed to draw in the air he requires from a supply-pipe, and to simply breathe it out by an exit-tube. If such were the case, the experiment would be equivalent to a man breathing in the open air; but evidently this is not what Dr. Smith supposed. The man's head being once more placed in the box, Dr. Parkes supplies him with 16 cubic feet of air for an hour, and he thus describes the result: "At his first inspiration the man draws in 30 cubic inches of air from the box-air (which is at once replaced from outside), and then expels it, so that 30 cubic inches pass out of the box. These 30 cubic inches will be partly derived from the air of the box which has not gone into the lungs, and partly from the air from the lungs; *consequently all the air from the lungs will not pass out*, but some will remain in the box and render the air there slightly impure. . . . At the next inspiration 30 cubic inches are drawn into the lungs [the void being replaced from outside], and are then breathed out, and simultaneously 30 cubic inches of air pass out from the box. The 30 cubic inches which pass out are again made up of a mixture of the box-air and the lung-air. It is evident that the box-air must at every expiration become more and more impure, although at the end of the hour the 16 cubic feet stated by Dr. Angus Smith to be sufficient will have been supplied." We cannot afford space for further extract, but we may mention that Dr. Parkes makes a very simple arithmetical calculation of the quantity of carbonic acid accumulated in the box at the end of the hour, and shows most

conclusively that long before this time the man would commence to be poisoned with his carbonic acid alone, to "say nothing of the organic matter evolved from his lungs.

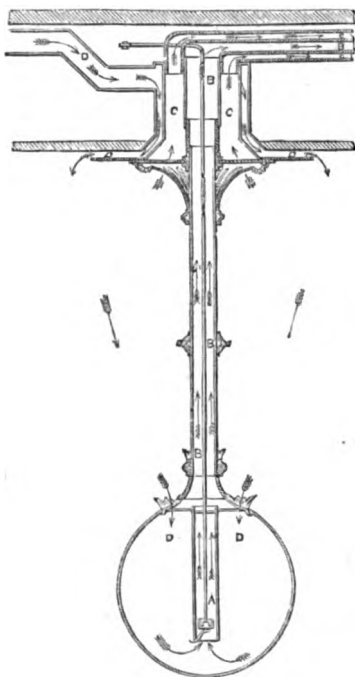
It seems to us that in all respects Dr. Parkes' explanation of the state of things in the supposititious case selected by Dr. Smith, is in accordance with theory and experience. However much we may be disposed to admit that complete diffusion does not occur, we cannot deny that there is considerable admixture of the gases, and this is adequate to bring in a verdict for Dr. Parkes. We see, then, that in calculating the quantity of air to be supplied to an individual, we must not be guided alone by the number of cubic feet of pure air consumed per hour. We must take diffusion into account. The proposition may be fairly laid down, however startling it may appear, that in order to make the conditions of respiration in a room as healthy as they are in the open air, *the whole air of the room should be renewed at each respiration*. But this would not be possible, for in order to do so, we should have to produce a series of air-currents which would be perfectly intolerable. Our object, then, must be to prevent the vitiation of the air beyond a point which can be borne without injury to health. In the air which we breathe out of doors, we find that there is 4 parts of carbonic acid in 1000 parts, and we know from experience that an atmosphere which contains 6 per 1000 of carbonic acid may be breathed with impunity. Our aim, then, must be—admitting diffusion—to supply such a quantity of air per hour as will keep down the pollution of the air to this standard. Here, again, arises the question, Can this be effected more easily in a small room than in a large one? This is a problem of some gravity; and, in our opinion, its only correct solution is that given by a mathematician—Professor Donkin, F.R.S. On this point we differ from both Dr. Smith and Professor Parkes. The former would, of course, allege that the smaller space is the more convenient; the latter contends that a larger apartment is more easily ventilated. According as we view the matter from different standpoints, each is right, though both, in our opinion, are in some respects in error. In a small room, with a very powerful out-draught, the quantity of air demanded per minute might be smaller than that demanded for a larger one. Again, in a large room we have the advantage of a large supply of air to dilute the poisonous gas. A little reflection, however, will show that in both cases, unless the increasing impurity be kept under, the rooms will, at a certain period, become uninhabitable. This, we think, is a point which has been overlooked by Dr. Parkes. Those who read Professor Donkin's observations on the subject can decide whether we are right or not; but we confess that we cannot see what the size of the room has to do

with the quantity of air to be supplied per hour. It is a matter for arithmetical calculation, but it seems to us by no means difficult to show that, whether the room be large or small (assuming it to be constantly in use), the quantity of air introduced must be the same in order to reduce its atmosphere to the standard demanded by hygiene. The quantity of carbonic acid developed per hour is a constant quantity; and as it diffuses itself thoroughly through the room, it is evident that the quantity of air required to dilute it to innocuity must also be definite. Of course, in applying this in practice, it is necessary to assume that the room will ultimately arrive at a certain degree of pollution by carbonic acid. And this is just the particular which shows that if the room be not constantly occupied, Dr. Parkes' view is correct. It takes a much shorter time to effect the pollution of the air to the required standard in a small room than in a large one. Hence in a room of great capacity the air might not become impure in the few hours during which it was in occupation. In hospitals and suchlike institutions it would, of course, be different. We cannot afford space to go into the calculation by which Professor Donkin arrives at his conclusion, but we may state that he believes 3,000 cubic feet of air to be the minimum which should be supplied per hour to each individual; this being, of course, independent of the size of the room. The question of size, however, cannot be passed over as unimportant, for the simple reason that in rooms of small size the necessary supply could not be introduced without the employment of strong currents of air, which would be not only troublesome, but might be even dangerous to health. But it must never be forgotten, that though a smaller supply of air may suffice to ventilate a larger than a smaller room for a short space of time, at a certain period, sooner or later according to the capacity of the apartment, the same quantity of air per hour must be supplied to both, and this must invariably be 3,000 cubic feet per hour for each person present.

Having arrived at the determination of the principle which should guide us in ventilation, and having established a rule for the quantity of air which must be introduced per head per hour into a room constantly occupied, we can now proceed with the second part of our enquiry—the methods by which the introduction of fresh air is effected. This part of our subject is of the highest importance, and, we might add, also of the greatest difficulty. It is obvious that in all arrangements for ventilating an apartment, it is the same thing whether we provide for the removal of a definite amount of foul air, or for the introduction of the same quantity of fresh. "Nature abhors a vacuum," and the elimination of the consumed or partially consumed air involves the introduction of an equivalent

volume of the outer atmosphere. It is, however, sometimes convenient to distinguish the two modes, especially in describing mechanical arrangements, and hence we find it usual to designate the "removal" the *vacuum* method, and the "introduction" the *plenum* mode. It may, at first sight, appear to the reader that the introduction of 3,000 cubic feet per head per hour into any ordinary room would be attended with serious inconvenience; but practically it is not found so. Indeed, if we take any room provided with a chimney and fire, we find that the quantity of air introduced per hour is much greater than we should have supposed. By means of a sort of scientific windmill, technically styled an *anemometer*, we are enabled (by counting its revolutions per minute) to estimate the velocity of currents of air; and then, the calibre of the shaft through which the draught passes being known, we obtain, by a little calculation, the exact quantity of air per minute supplied by any aperture. We mention this here because the *anemometer* has been placed in the chimney of an ordinary room when the fire was burning, and its revolutions showed beyond all question that 1,004 cubic feet of air per minute, or upwards of 60,000 cubic feet per hour, passed out of the room, and must have been replaced by an equal amount which entered by the usual channels. Thus, in this case at least twenty people might have been supplied with a healthy atmosphere, provided the air was not heated to too high a point. It is customary with writers on ventilation to speak of natural and artificial systems of ventilation; but as in most cases a fire exists in what is termed the natural arrangement, the division is more empirical than correct. Without, then, employing this distinction, let us consider the condition of one of our sitting-rooms in winter. The fire burns brightly, and, as a consequence, several thousand cubic feet of air are hourly drawn up the chimney. Whence comes the air to replace this loss? The chinks in the door and windows are constantly admitting a stream of cold air, and thus ventilation is effected at the expense of draughts, which produce chilled feet, catarrhs, and so forth. Still, ventilation takes place. We are now supposing that the lamps have not been lighted; and we think everyone's experience will show that most rooms in which a fire burns well are tolerably well ventilated (*quoad* the amount of air) till, say, the gas is lit. The moment the chandelier comes into operation (supposing it to contain five ordinary fish-tail burners), the state of things is changed, and in the course of half-an-hour or so, this change becomes distressingly perceptible. Why?—People never ask themselves this question. Because more than twenty additional pairs of lungs have begun to use up the air, each burner in use being equivalent to nearly five persons. This is the great defect of our modern

dwellings. In olden times ventilation must have been far better than it is nowadays, when our demand for light is followed by so large a consumption of our breathing-air. And why, again, is there this distinction between the fire and the gas? The fire uses up air, but it also acts on the *vacuum* principle, and produces a

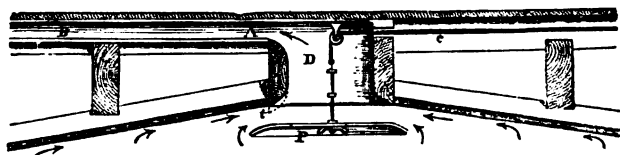


VENTILATING GLOBE-LIGHT.

draught of fresh air in the room ; but the gas does not. What, then, is the remedy? Convert the gas into a fire, provide it with a chimney to convey out the products of combustion, and compel it thus to ventilate the room as thoroughly as the fire does. Many methods of doing this have been suggested, but the one which has been found most satisfactory in operation, and of which we ourselves can speak in high terms of praise, is that which has been invented by Mr. Ricketts, and is known as the Ventilating Globe Light. We have only one fault to find with it, and that is its costliness; but we confess we cannot see how, under existing conditions, it could be sold at a cheaper rate. The accompanying diagram explains its construction. It consists of an Argand burner, enclosed in a globe of large proportions, whose only aperture for

admission of air is at the top. A shows the burner and chimney in section, and the letters D D and the arrows indicate the mode of admission of air from the room. The gas-pipe is enclosed in a tube of larger dimensions, B B, which passes from the portion of the globe immediately above the chimney of the burner to the ceiling of the room. Here it communicates with a shaft, which passes under the joists of the room above, and discharges the foul air into the chimney. The letters C C indicate a funnel, whose mouth communicates also with a portion of the shaft, and which draws off the heated air of the room, throwing it—as in the case of the products of combustion from the burner—into the chimney. Thus far, Mr. Ricketts' contrivance is theoretically excellent. Our examination of it in these respects confirms the inventor's anticipations; it not only carries off the products of its own combustion through

the outlet tube, but the funnel removes much of the heated air of the room—tobacco-smoke, vapour, and such like, passing up with great rapidity through the apertures in the “ceiling-flower.” It will be observed that the diagram shows a pair of tubes external to the funnel and communicating with an inlet tube, the arrows here indicating a passage of air inwards. This is an addition to Mr. Ricketts’ lamp, which was suggested by Mr. J. P. Seddon, Hon. Secretary to the Royal Institute of British Architects, and which strikes us as more ingenious than efficient. Its object is the introduction of cool fresh air from without, thus converting the lamp into an apparatus for ventilating perfectly closed rooms. It is only fair to say that we have not gone carefully into the examination of this addition; but our observations, so far as they went, tended to prove its utter inutility; indeed, so far as we could perceive, it acted more as an outlet than anything else; but on this point we are desirous of further experience. In every other particular, Mr. Ricketts’ plan seems to meet a great want; and we doubt whether in winter (when fires are used) any other mode of getting rid of foul air is required. But for those who do not care to go to the expense of purchasing one of the globes, we should recommend the employment of an outlet-shaft, expanding at one end into a cone, situated over the ceiling-flower, and opening at



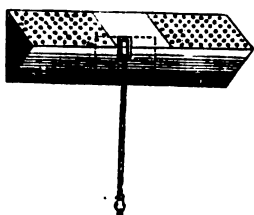
OUTLET SHAFT.

the other extremity into the chimney. This we have seen in some houses, and its effect has been admirable. A somewhat similar contrivance is shown in the adjoining cut. Indeed, the “sun-light” method of illumination is generally one of the best modes of ventilation; and gas-lamps, provided with the above arrangement, approach them in usefulness. No system of ventilation can be considered perfect in which the gas-lamp is not made to carry away the air vitiated by its use.*

We come now to another consideration, which, if of not so grave a nature, at all events demands every attention. We refer to the mode of introduction of pure air. At present, in most

* We have not noticed Arnott’s chimney-valves and other similar contrivances, because we have no faith in their efficiency. They occasionally interfere with the draught of the chimney, and in some instances allow smoke to pass out, and thus injure ceilings, cornices, and such like.

sitting-rooms the fresh air comes in at the windows and doors, and when no other arrangement exists, we are sure to have draughts more or less injurious, according to the size of the interstices, apertures, &c. The question of where to introduce the cold air has always been a vexed one with hygienists. Even now, it cannot be looked on as definitively decided. Some writers say, introduce it through the floor, as in the House of Commons; others suggest a middle point between floor and ceiling; while the latest researches seem to show that the ceiling itself is the best point. Whether the air be introduced at the level of the ceiling, or at a sufficient height above the door to prevent unpleasant draught, is, in our opinion, immaterial. The great points to be attended to are the distribution of the air by causing it to pass through an immense number of apertures, and the employment of adequate means to bring it to a suitable degree of temperature. In most of the existing arrangements for the introduction of fresh air into rooms, the mistake is made of using a few small apertures (Sherringham's ventilators *et id genus omne*). Hence, we often find in the houses of persons who pride themselves on the perfect ventilation of their rooms, that these latter have abominable draughts, whose course is defined with the greatest nicety, and which often appear to select one's ears as the most convenient medium of transit.* This production of keen, sharp draughts has been the opprobrium of nearly all the vaunted ventilators hitherto employed. The method suggested by M. Morin, a French savant, who has paid much attention to such questions as these, obviates in a great measure these defects. His plan is



PERFORATED ZINC CORNICE.

somewhat similar to that recommended by the Commissioners for Improving the Sanitary Condition of Barracks and Hospitals, so that a description of the latter will represent both. At the level of the ceiling a number of perforated bricks are introduced into the wall, the area of the aperture being in the proportion of 1 square inch to every 60 cubic feet of the capacity of the room.† In order to prevent the discomfort which might arise from a down-draught from these openings, a cornice is so arranged as to cover them.

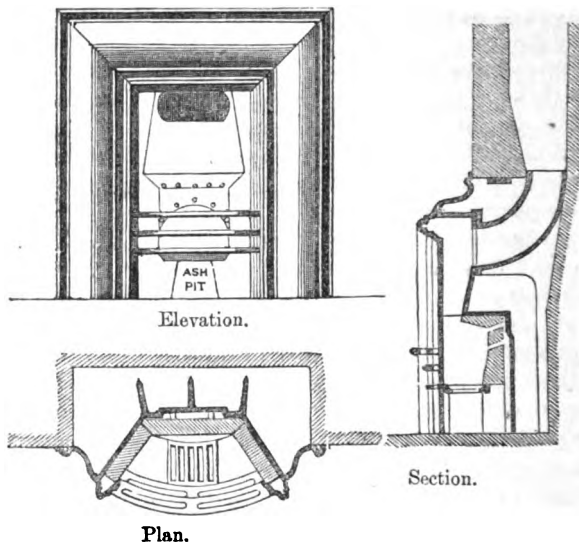
* Such draughts recall the sailor's saying, that he "didn't mind a fresh sou-wester, but he was blowed if he'd sit in the 'wake' of a key-hole."

† A room 25 feet long by 18 feet wide and 10 feet high would have a capacity of 4,500 cubic feet. Its apertures for entrance of fresh air would therefore be $4,500 \div 60 = 75$ square inches. How large an area compared with the apertures now occasionally found over our doors, and misnamed ventilators!

The upper side of this cornice is composed of perforated zinc, which thus causes the air to be evenly distributed over the room. The holes are generally from $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter, and the area of the zinc perforated is to that of the air-spaces as about 6 to 1.

Few systems are better adapted for the introduction of fresh air than that of the Barrack Commission above referred to, provided it is not required to heat the air before it is introduced. When the air has to be heated, a new set of contrivances is necessary. For ourselves, we think that, provided the cold air is brought into a well-heated room at such a level as to increase its temperature before it is breathed, and so distributed as to prevent draught, there is little necessity for any special device for warming it. In some cases, however, it appears to be necessary; and various appliances have been employed in raising it to its proper temperature. Of closed stoves for warming the air, there have been legion; but, we think, in all cases they have proved objectionable, for they either burn the air which passes through them, and thus render it most unwholesome, or they impart to the heated air certain metallic impurities, which are not only offensive, but hurtful. There may be exceptions to this rule; but, if so, we have not had the good fortune to meet with them. Of hot-water and steam apparatus, for the same purpose, we cannot speak in favourable terms; they may, doubtless, be economical, but they are unsatisfactory from the two facts, that—1. They produce an atmosphere which contains impurities arising from the heated tubes, and which is extremely distressing and unwholesome; and 2. That they are not unattended with danger, from the circumstance that rupture of one of the pipes is likely to severely scald those in its proximity. The open fireplace seems in all cases to be the best means of warming, but it may be constructed so as to give out more heat than the average grate does, and may be contrived to supply warm air to a room. The following description of the open grate recommended by the Barrack Commissioners will demonstrate this. Though this grate is not absolutely new in principle, it is not constructed on any one of the old plans, but appears to be, as stated by Mr. Tomlinson, a combination of all the good points in the older inventions: "The grate is placed as much forward in the room as possible. The part in which the fire is contained is of firebrick; the bottom being partly solid, checks the consumption of fuel; a supply of air is admitted from behind the grate, and is thrown on the top of the fire to assist the prevention of the smoke. The sides are splayed so as to throw the heat, by radiation, as much as possible into the room. The opening into the chimney has no register. There is a chamber behind the grate into which air is brought

from the outer air, and warmed by the large heating surface of the back of the grate, increased by flanges, and, after being

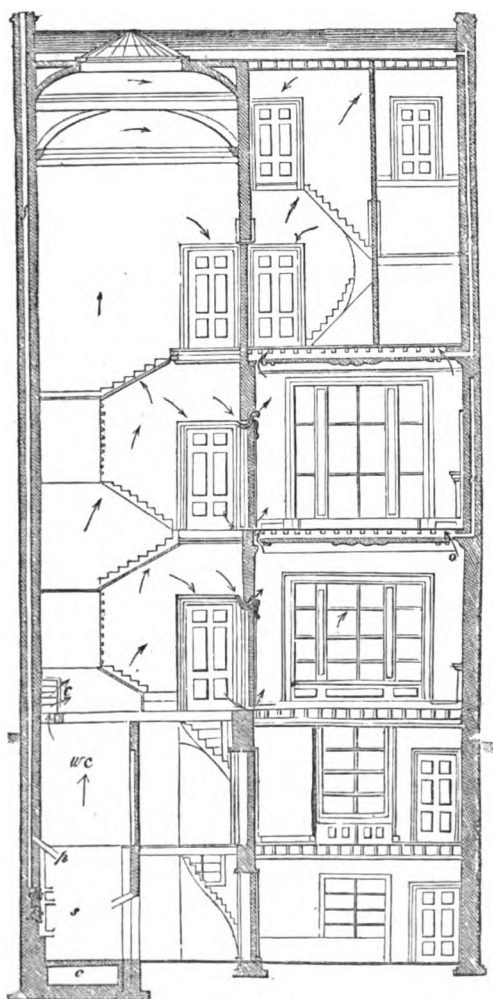


BARRACK COMMISSIONERS' OPEN GRATE.

heated from 65° to 70° Fahr., the air passes into the room by a shaft cut out of the wall, and which terminates in a louvred opening placed "near the ceiling. This is, we believe, one of the best devices yet in operation, and it is the only one we should venture to recommend. The plan of heating the air of a house by placing a closed stove in the lowest chamber, and causing the fresh supply to enter each room at some point above the door, is thought satisfactory and efficient by those who have tried it, and is said to work thoroughly well in Sir John Robinson's house at Edinburgh, of which the adjoining woodcut represents a section. The air is heated in the basement storey by what is known as a "cockle stove." Thence it ascends along the staircases, and enters the various apartments through ventilators above and below the doors. The vitiated air passes through apertures in the ceiling of each room, and into a shaft whose outer opening is above the roof of the house. We have no personal knowledge of the efficiency of this plan of ventilation, but it is alleged to be perfect.

It remains for us to say a word or two about the ventilation of sitting-rooms in summer. In warm weather it frequently happens that the ventilation of rooms is a matter of some difficulty. In the daytime, the only natural mode of ventilation is

through the open window, and unless this be supplemented by an artificial contrivance, we know of no other better method. At night, the employment of gas, with a central air-shaft, is likely to produce a tolerably good in-draught by removing the foul air. The chimney, too, is thought to assist in producing a current



SIR JOHN ROBINSON'S HOUSE.

outwards, but this does not always happen ; indeed, it not unfrequently occurs that the draught through the chimney is into, not out of, the room. A convenient mode of remedying this, but one which is seldom used, is to keep a small gas-jet burning

in the grate. This is quite sufficient to produce a very powerful out-draught of air, while it adds nothing to the temperature of the room; its expense, too, is slight compared with the benefit it confers, and there is little difficulty in arranging it, as a flexible varnished tube may easily be carried to the burner from a joint fixed in the neighbouring gas-pipe.

Had we not already transgressed the limits originally assigned to our remarks, we should have entered on the subject of mechanical systems of ventilation—such arrangements as the steam-fan employed in the Reform Club House, the furnace of the House of Commons, the air-filters of the Post Office, the steam-jet employed by Dr. Edmonds in ventilating the lower decks of ships, the heated-tube system of Mr. Sutton for a similar purpose, and various other contrivances, whose names alone constitute a formidable list; but we must draw our observations to a close. What we have said, has been said rather with a view to draw the attention of the thoughtful to a subject of the most vital interest, than to convey the idea that any perfectly satisfactory scheme of ventilation has yet been proposed. Our aim has been to lay before our readers a general expression of the conditions as to the quality of air necessary for healthy ventilation. This, we think, has not hitherto entered sufficiently into the considerations of those who have pursued the study of methods instead of principles. It must, nevertheless, be admitted that no system of ventilation can be satisfactory unless it be in accordance with the laws of hygiene. Of these laws, as they relate to ventilation, we have given our readers a general idea; and we would, in conclusion, assure them that since they are capable of mathematical demonstration, they must inevitably form the basis of every efficient plan for the maintenance of a healthy atmosphere in our private dwellings and public buildings.*

* With one or two exceptions, the woodcuts illustrating this article have been borrowed from Weales' excellent treatise on "Warming and Ventilation." For the stereotypes we are indebted to the courtesy of Messrs. Virtue.

PHYSICS OF THE BRAIN.

By B. W. RICHARDSON, M.D., F.R.S.



I HAVE recently been carrying out some new researches on the brain, with the view to discover its several seats and places of function, and the Editor of this Review thinks that I may be able to make the nature of the research so simple that all who may read will follow. I do not see why I should not; for, after all the terrible obscurities thrown about it, the brain is an organ not very difficult to understand. It comes sharply enough under the Gladstonian definition of flesh and blood, and when we have the courage to approach it, and look into it, it gives way to inspection with moderate facility.

THOMAS WILLIS, M.D., AND HIS PART.

I find in books of learning and knowledge no glimpse of satisfactory thought, guess thought or real, respecting the brain, up to the time of Thomas Willis. Willis lived in the reign of Charles Mutton, sometimes called Charles the Second, and Willis died in the same reign, his death accelerated, it is said, by a cruel joke of the mutton-king. I have at this moment before me a small portrait of this first physical philosopher of the brain, the man who had the courage scientifically to open the skull-casket and find out what was the nature of that rounded structure which, like a world within a man, takes in all that is outside the man and binds him bodily with the universe. The face of Willis, as it looks up at me through the long gap of two hundred years, is strikingly singular. It is a pensive face with a meaning in it, determinate to a fault, and yet with a modesty of expression that shows a sensitive soul behind:—the face exactly of a man who under the smart of a king's joke resounding everywhere would feel acutely and break his heart in silence rather than reveal the pang.

What nonsense was talked about the brain prior to the time of Willis, I need not stop now to state; except one fact which illustrates many more. There was a notion that a common cold was the phenomenon of the direct distillation of brain-stuff through the nose, and it is worthy of note that men of the

Willis school had as much trouble in disposing of this mild delusion as they had in setting forth positive discovery.

The discoveries of Willis were indeed very grand when measured by what they dispelled and by what they proved. That the brain was an organ of actual flesh and blood; that it was nourished by blood, and was specially well supplied with blood; that it was covered with membranes and divided into distinct parts; that animals had brains built of the same matter as human, but of less magnificent quantity; and that the quality of mind had relation to the quality of brain with varying gradations through the scale of living organic being—these, in the rough, were certain of the gigantic truths taught by the dutiful and right loyal subject of Charles Mutton.

AFTER WILLIS. GALL, AND HIS PART.

After Willis, the brain became a fine field of study for anatomists of all schools; but, with a few exceptions, anatomists have never been more than industrious men, painstakers, with some hard observance and little insight; and so it happened that the poor brain, cut up after the fashion of cutting up a Dutch cheese, was subjected, long after it was discovered as an organ, to infinite anatomical torture and fearfully insulting misnomer. To this day, the names given to certain parts of the brain are painfully absurd: it is made to have valves and writers' pens, fissures and roads, bridges and canals, beds, curtains and floors, hard bodies which are really soft, and white bodies which are not white, to say nothing of two approximate parts really not mentionable, even in simile, in polite society. At length the physical metaphysical labours of Gall helped somewhat to render the study of the brain less nominal and less obscure. Gall, by his dissections, by his careful tracing out of the diverging fibres, and by his happy and, in many respects, correct and simple divisions of the organ into centres, placed observers on a train of research which was full of promise. Unfortunately his disciples, not excluding the distinguished Spurzheim, followed in the metaphysical direction to which their master had led them, rather than to the physical. This tendency was in every sense natural. It was the continuous road of enquiry, much widened and more soundly paved, while the physical highway was doubtful from its newness, and especially from the labour demanded for traversing it. The metaphysical path was luxurious, open, and tempting even to fascination; the physical was hard, narrow, and unpromising, nay threatening, to the beholder. Thus sprang up the system of Phrenology, a system in advance of facts, and therefore, though containing many truths, a system based largely on belief, and fluctuating as belief itself.

AFTER GALL. MAJENDIE AND OTHERS, THEIR PARTS.

Meanwhile, to a large extent, the old anatomy of the brain has remained but little changed; still exist the absurd names, meaningless, bewildering, and so adhered to, that within the last five years two of the greatest lights in comparative anatomy of this age have been holding desperate contest on one poor nodule, the physiological value of which is altogether unknown, and indeed little cared for, in respect of its function, throughout the controversy. At the same time, it is right to explain that the progress of rational physical discovery, into the nature and function of the brain, has been advancing with some determinate casting-off of the mystical and hypothetical. The classification of the brain into ganglia or centres of power, and into commissures or connecting bands, and the tracing of nerves into the brain-structure, a study which the late Mr. Grainger so admirably and industriously promoted, have all been aids of no mean value to the direct and positive appreciation of function. In the way of minute anatomy, also, a wonderful field of truth has been laid open, especially by the labours of Swan and Lockhart Clarke: while the chemists have been indefatigable in determining the chemical constituents of the organ and their relation to each other. Finally, the pathologists, in a quiet and unassuming research, have added a long array of new facts on this vast subject. Observing the phenomena of disease in instances where the functions of the brain have been disturbed, they have sought, after the death of the subject in whom the symptoms were presented, to find the precise seat of the disease, and so to trace the living phenomena to their true cause. In this direction our accurate and philosophical countryman, Dr. Wilks, of Guy's Hospital, has taken a part which is beyond all commendation. I must linger no longer on these matters, but must proceed to note some purely physiological facts, for the illustration of which this paper is specially intended. To Dr. Philip, Majendie and Fluorens we owe the first real steps in advance for exploring, by physical experiment and analysis, the functions of the brain. It was unfortunate for these observers that their work was laid out before they had the necessary means for conducting it with satisfactory exactitude. Their experiments, often singularly accurate, were, from the mode of their performance, open to criticism. Knowing nothing of any methods for modifying brain-function short of actual removal of portions of the brain of the inferior animals, they proceeded by what is called ablation, or cutting away, of the living structure. The result was that they took what they could not restore, and, as a consequence, left it often doubtful whether the symptoms they

elicited were those of mere shock, injury and pain, or of actual dismemberment of function.

DR. JAMES ARNOTT. HIS PART.

The great leading discovery that the brain of a living animal could be frozen and afterwards could recover was made by Dr. James Arnott, who solidified the brain of a pigeon by exposing it to a freezing mixture. Here research stopped, because with an ordinary freezing mixture it was not possible to act on individual parts of the organ; but the importance of the discovery is not the less on that account. It was a marvellous revealing. Think what it was! Here was a living organ of mind, a centre of power—of all guiding power, of all volition. It took in every motion of the universe to which it was exposed. It took in light and form and colour by the eye; it took in sound by the ear, sensation and substance by the touch, odour by the nostril, and taste by the mouth: it gave out, in return or response, animal motion, expression, all else that demonstrates a living animal. With it the animal was an animal; without it the animal was turned into a mere vegetable. And this organ, the very centre and soul of the organism, was, by mere physical experiment, for a time made dead—all its powers ice-bound. And this organ, again set free, received its functions back again, and, as we know now by further observation, its functions unimpaired. Surely this was the discovery of a new world! The discoverer of such a world needs no praise, for to him comes honour as a birthright, the noble birthright of an interpreter of natural truths deep from the depths of nature in her most sacred treasury.

RECENT RESEARCH. FREEZING THE WHOLE BRAIN.

Recently, by the advancement in the means of application of extreme cold, we have had laid before us a new line of enquiry; we have been enabled to destroy portions of the brain, as well as the whole organ, temporarily, and we have been also enabled to observe the process of recovery from this form of brief death. Thus we have witnessed death of parts of the brain, and their restoration from death, and by comparing functions lost with functions regained, have traced out, with singular correctness, many facts which by no other means could have been so certainly revealed.

I was myself so favoured as to learn a simple mode of producing an intense cold with volatile fluid in the form of spray, and of so adapting this that even the brain could be

temporarily destroyed in parts or sections. Then I and another physiologist, Dr. Weir Mitchell, of Philadelphia, took up simultaneously and independently the study of brain function by destruction of part. The truths thus learned, in so far as they relate to my own work, I would now record. I put them forward as being yet limited, but not valueless.

I shall begin the narrative best by stating that the brain matter contains two substances which admit of solidification by cold, viz., water and fatty matter. These solidify at different temperatures, but both are entirely frozen by reducing the temperature to 16° Fahr. or 16° below freezing point. At this degree all the water of the nervous structure, amounting to 84 per cent. of the whole, is crystallized as ice; in this condition the structure is for the time dead, it is as though it were removed from the body altogether.

Suppose, then, that we bring into this state of temporary death the front part of the brain, the two lobes or hemispheres of the cerebrum or larger brain, which mainly fill the skull. The phenomena produced are those indicating entire loss of volition, of sensation, of all that may be considered intelligence. To appearance the animal profoundly sleeps, it is as if it were under the influence of chloroform or ether, and an operation of any kind may be performed upon it without pain. It may, nevertheless, move when handled, and it may show a kind of involuntary life due to what is called spinal action, to some power resident in the spinal cord. A frog thus circumstanced will sometimes leap; but warm-blooded animals, as a general rule, will remain like as in catalepsy, always retaining the position in which they last were left.

In cold-blooded animals, as in the frog, when the functions of the brain are entirely suspended, the freezing process may be carried to and through the spinal cord, and every portion of the nervous system may thus be deprived of force, the animal remaining motionless, rigid, and indeed like stone. In this state it would remain, I believe, for an unlimited period of time if it were kept under the same condition of temperature; but from this extreme condition of shrunk death it will, nevertheless, recover on gradual restoration of warmth. In some warm-blooded animals we see an approach to this same state, naturally brought about in the period when they are hibernating, in the profound sleep of the cold season; but there is this difference, the animal, during hibernation, still breathes, and still takes in some air for respiration, without which it could not recover with the return of warmth. And we find by experiment that if the process of freezing artificially be carried on in a warm-blooded animal, from the brain into the spinal system, so as to stop

the function of respiration, the living action is put an end to for good.

The statement of this fact will naturally suggest the question, Why is there this difference between warm and cold-blooded animals; between a frog, for instance, and a pigeon? The answer to the question is simple; the frog requires only, for its best life, a comparatively low temperature, and its outer covering or skin is a fair conductor of heat. Hence the frog, after being entirely frozen, can take up sufficient caloric from a warm air to become recharged directly with force throughout all its nervous organism; but the warm-blooded animal, living always by the heat it develops in its own body, is protected by a skin covered also with a good *non*-conducting surface of feathers, or fur, or hair: it cannot, therefore, so receive heat from without as to be able to recharge its nervous centres from any external source of heat; it dies outright whenever its internal and radiating force is cut off.

To return to our animal made lethargic and insensible by the direct abstraction of caloric from the cerebrum. I have said that it resembles an animal sleeping after the inhalation of chloroform, and this is indeed what is observed. A pigeon will lie motionless and insensible for long periods of time, breathing slowly, but regularly, and with the heart beating in even time. By allowing the temperature to be gradually raised to 60° or 65° Fahr. there follows steady recovery and return of living function; but the order of recovery is not always the same, variations being introduced dependent upon the parts in which restoration begins. Usually, however, when the whole mass of the cerebrum, or larger brain, is frozen, recovery of intelligence is the first sign exhibited; then there are attempts at motion, which are propulsive forwards, and soon afterwards there is sensation. I have, however, seen this order reversed, the sensation returning before the return of motion. Finally, the animal entirely recovers, and with the recovery memory and all the spell-bound faculties return into active play. The brain has been crystallised, and it has been loosened back to the fluid state, but it has lost as little as it has gained; all impressions it held it has retained, and the light, and the sound, and the touch, and the odour, strike again to reach and endow the now impressionable matter.

FREEZING SECTIONS OF BRAIN.

So far we have seen the effect of removing force from the cerebral part of the brain substance as a whole; let us next enquire what is the effect of removing force from special parts of the organ. As preliminary to this description I should explain, that the brain substance being a bad conductor of

caloric it is quite possible, by using a fine ether jet and a low boiling fluid, to isolate parts with great minuteness. Thus we can remove the force from the two large front cerebral hemispheres without removing it from the smaller hemispheres which lie behind, and which form the little brain or cerebellum; it is possible again to remove the force from one hemisphere without removing it from the other, or from the spinal cord without interfering either with the large or the small brain.

In the superior and front part of each hemisphere of the cerebrum there lies a mass of nerve matter very distinct in form, and, as it would seem, very distinct in function. The older anatomists called this the striated body (*corpus striatum*), because in section it appears to be marked by faint lines of grey and white colour. It is now more correctly called the superior cerebral ganglion. With very little difficulty, and without pain, we can expose this ganglion in one or both hemispheres, and remove the force from one or from both. When we have removed the force from both—when, that is to say, we have solidified them, and, for the time, destroyed their function—there is presented this singular phenomenon: the animal falls forward, or sometimes rushes forward with unmeaning impetuosity, and these symptoms will last until the relaxation and restoration of the ganglia is complete.

We change the line of experiment; we turn from these front cerebral ganglia to the lower large ganglia which lie at the back of the skull, and form the smaller brain or cerebellum. We lock up these, by taking from them their force by cold, and at once the animal marches backwards, and turns backward summersaults, and in the most determinate manner shows that it has no control over these movements until its cerebellum is set at liberty by the restoration of caloric.

If the anterior cerebral ganglia, together with the cerebellum, be simultaneously deprived of force, there is neither backward nor forward movement, but prostration of movement for the time, with equal restoration of power consequent on equal restoration of force.

Throughout all these induced changes on the great centres of nervous power, it is observed that however much the volition, the perception, and the sensibility of the animal are reduced, the semi-voluntary and involuntary acts, the acts of respiration and the motions of the heart, are not prevented. To say they are not affected is not strictly true, for they are rendered slower after a time and feebler; but this is an indirect retardation of function, and would occur if any other large surface of the body were for a long period deprived of caloric; but we may say, confidently, that the removal of force from the large and small brain does not seriously interfere with the functions named.

When, however, we pass beyond the great and little brain and approach that part of the spinal column which is in immediate connection with them, we are introduced to new phenomena. The part immediately leading from the brain is called the medulla oblongata, and as we subject that part to the influence of the extreme cold we instantly interfere with, and even stop, respiration, so that the animal, if it be a warm-blooded animal, will die, as suddenly as dies the Spanish bull from the short sword-thrust of the skilled Torero; but the heart still continues in action, and, if the breathing be sustained by artificial means, the heart will remain in action even though the influence of the cold be made to extend to the whole of the spinal cord.

When only the upper surface of the cerebrum or large brain is superficially frozen, the power to move remains, although the perception and sensation are entirely destroyed. Indeed, in this condition there is often active movement of the body, but altogether without will or desire. The motion in this case is not motion of one particular and exaggerated type, but general, uncontrollable motion, such as is seen in some forms of insanity in man.

I might extend these observations respecting the removal of force from the brain, but I see I am already trespassing on the pages of the Review, and I feel that I have given enough of experimental fact to illustrate as much as I can this time put down upon paper.

DEDUCTIONS.—THE FORCE AND THE MATTER.

On reviewing the facts disclosed in the experiments that have been described, we learn that the force by which all the manifestations of brain function are sustained is the force we call caloric, or commonly, and by incorrect speech, heat. Two evidences lead to this truth: the first, that all the manifestations are withheld when caloric is withdrawn; and the second, that all the manifestations return when the caloric is restored. But inasmuch as with the restoration of action, there is continuance of the impressions which were made on the brain before any force was drawn out of it, it follows that the extant force in the brain at any given moment, is not the seat of the impression, nor the cause of it, but the means by which the matter of the brain is held ready for the reception of the impression, and for the production of those manifestations which we denominate functions. We are bound, therefore, to infer that impressions are physical realities, stamped as it were on brain matter, each distinct and perfect when the matter on which it is set is in condition for motion. Everything we remember is, I doubt not, thus imprinted on the brain, on infinite points of brain

substance, each independent, free, and capable of motion when the whole mass is charged with force. The brain, in fact, is a world within of the world without, a camera of all from the world without that it has received in the course of its waking life. Until recently the idea of such a physical microcosm could not have been conceived; now it comes forward strengthened by physical truths of human invention so called. I hold a piece of transparent glass in my hand and see nothing upon it. Nay, says my friend the micro-photographer, look again. Still nothing there? No! Then he slides the glass under his lenses and adjusts, and repeats, "Look again." I obey, and lo! before me on an infinitesimal space of matter is the Pater Noster, as legible as it used to be in an old church I well remember, where it covered half a wall, and, with the ten commandments to balance it, enframed the Lion and the Unicorn, and Georgius Rex, and the Garter, like a holy family.

When we see what the micro-photographer can thus do in putting physical impressions on what seem infinitesimal points of matter, and when we know that there is no assignable limit to his art, it is no crude inference that in the vast surface of the grey matter of the brain, in those cerebral lobes of which I have spoken, myriads of points of matter are thus impressed—points of matter floating in that eighty-four per cent. of water of which the brain is made up. I call up to remembrance a ridge of hills which were often before me in childhood. I see them in all the distinctness of that time, their height, their breadth, their length, their divisions, the structures upon them, all their belongings. Why do I see them? Because they are actualities still in my brain, imprints on points of matter there. But twenty years elapse, and I look on those hills again, and they are and yet are not what they were. They seem to my present view smaller, that is certain; and one of them was barren, and now it is cultivated; and one had a mill on its summit, and the mill is gone; and one had two or three trees on its side, which in the distance looked like the flint and steel of an old-fashioned gun, but now in place of those trees is a copse. These are not the hills, in fact, which I have carried so many years, for now as I take them in once more my capacity for taking has changed and the hills have changed. I must have therefore a new picture altogether; and from this time forward I must carry two pictures of those hills, the child's picture and the man's picture; for the old is not put out by the new, nor the new by the old.

Physical points of brain for physical impressions are then essential; but to reveal their impressions they must have force and condition for motion. Let us remove that force, abstract it, as it comes to the part, by cold, or crush it out by firm mechanical pressure, or cut it off at its source by putting out

the animal fire, and then the impressed molecules, losing condition for activity, and coming to rest, cease, functionally to exist.

But they do not cease actually to exist; because, whether they be bound in ice or bound by pressure, we see that when they are unloosed they can return, if the body can supply them with caloric, to full vigour. Indeed, the images of the brain, once well developed and fixed, can only be obscured by derangement of brain matter, and can only be destroyed by disintegration of brain matter. Cases have occurred in which, under pressure of brain, a man has been for months dead to the outer world, and, on recovery has remembered what preceded his accident, showing thus that the imagery of his brain remained intact; and, as I have said already, an animal with a frozen brain, when it is restored, will not show an evidence of a lost faculty. By disintegration of brain matter the world within of the world without only dissolves. This disintegration is, in all men and animals, going on slowly, and thus memory becomes defective. In second childishness this gradual metamorphosis, this natural mode of removing the world and its past from the man, is completed; it is the dissolving view of nature. In the vigorous the imagery of the brain is finally destroyed by death alone, and by death not of necessity immediately, but with the after disintegration of structure. A brain frozen in a living animal, and with the animal crystallised in ice, would retain, in that condition, the imagery with which it was replete for any grasp of time; for time is no element when there is no change, nor is it recognisable by aught except change of matter by force. When I wind up my watch I put into it so much force, which force is expended in moving so much matter, and the measure of that movement is the measure of motion,—time.

The force called caloric, then—the force we liberate in the combustion of blood—is the sustaining force of the brain, but it is not the only form of force to which the brain is impressionable when its natural condition is maintained. Through the eye calorific force does not pass to the brain but is cut off, yet the form of force called light, and probably the actinic force, make way; while through the ear and tactile skin common mechanical force finds ingress. We see, we hear, we feel, in fine, by the direct action of forces other than caloric, but without caloric as the base these are unavailing, for an animal with a frozen brain cannot be awakened neither by light, nor by noise, nor by touch; if it could a dead animal could be awakened by the same means.

SLEEP AND DREAMS.

The course of our research leads us, as we have seen, to contemplate the condition of the brain in its active state, and under

artificial states in which its functions have been suppressed. But we are led also to another subject, I mean the natural inertia or rest of the brain, which we call sleep. Physically the brain asleep is the brain exhausted of its force—force expended during waking hours in the production of its equivalent of animal motion. As the sleep creeps on, the natural imagery of brain rests. During sleep, motion being suspended, the brain and nervous centres altogether are recharged, and natural awaking is the index of the fact.

But it is not always that the brain centres rest as a whole, or work as a whole. Sometimes one part of the brain works while the rest sleeps, and then we dream in sleep, sleep being the major phenomenon. Carmichael, many years ago, well taught that there are seven distinct stages of waking and sleeping. 1. *When the entire brain and nervous system are buried in sleep*, then there is total exemption from dreaming. 2. *When some of the mental organs are awake, and all the senses are asleep*, then dreams occur and seem to be realities. 3. *When the above condition exists, and the centres of voluntary motion are also awake*, then may occur the rare phenomenon of somnambulism. 4. *When one of the senses is awake with some of the mental organs*, then, during our dream, we may be conscious of its illusory nature. 5. *When some of the mental organs are asleep, and two or more senses awake*, then we can attend to external impressions, and notice the gradual departure of our slumbers. 6. *When we are totally awake and in full possession of our faculties and powers*. 7. *When, under these circumstances, we are so occupied with mental operations as not to attend to the impressions of external objects*, then our reverie deludes us like a dream. These are faithful observations, and define with exactitude the fluctuations of force in the brain under different conditions. In experimental research, and in disease, we have the same phenomena brought before us, and they all accord as to cause.

INTOXICATION.

There are various modes of producing insensibility artificially. The insensibility of intoxication from alcohol is an illustration at hand. The insensibility thus produced is the same as that from cold; the agent taken, that is to say, interferes with the distribution of force through the brain substance, and is carried away at the expenditure of so much force as shall be required for its elimination. At the late meeting of the British Association for the Advancement of Science at Dundee, I showed that the period of action of alcohols of different kinds could be determined by the force required to lift them out of the organism. Moreover, various of these intoxicating substances,

which all act in the same manner as cold, pressure, or exhaustion, affect differently sections of the brain matter, producing various phenomena analogous to dreams.

Lastly, some other external influences, by causing concentration of force on one particular part of brain, may so reduce other parts to rest as to cause that inertia which Carmichael calls reverie. This is a disturbance of the equilibrium of force in the brain which can be intensified by practice; and there is no difficulty in tracing the phenomena of mesmerism, such as they are, to their physical source when the nature of reverie, or waking dream, is explained and understood.

BALANCE OF POWER IN THE BRAIN.

One more fact relating to the physics of the brain, as taught by experiment, and I have done. We have seen that when the anterior cerebral ganglia are destroyed for a time, an animal moves impulsively forward, and that, when the cerebellum is destroyed, the animal moves impulsively backwards. This indicates the existence of a balance of power between these centres—a balance which is also detectable between other centres. It is therefore a fair inference, that every centre of power in the brain is, during healthy states, physically balanced, and that what is called a well-balanced mind is really a properly balanced brain. By this reading we explain many phenomena of living action otherwise inexplicable.

By constant overaction one centre of the brain may gain undue power, which shall be so persistent as to distinguish the man throughout life. Or a centre of power may be suddenly prostrated, and the balancing centre, no longer controlled, may overcome all for the moment, and produce phenomena not before observed in the same organism. Impulses—sudden, vehement, propulsive, onward, under the influence of any impression which for a moment paralyses the cerebrum, are thus explained. Whenever the cerebrum alone is overcome with sudden shock, it fails in power the same as when its structure is deprived of force by the direct action of cold or by pressure: then the propulsive cerebellum unaffected shows its force unchecked, and there is forward rush. In some stages of disease of the cerebrum and specially of disease induced by alcohol, there is this break of balance. I lately pulled out from under a railway train the headless trunk of a man. Passing into a tunnel out of which the train had emerged, I found the brain of this man entire, and while the servants of the company were fetching the police, I read in the brain his physical history, and interpreted it to the Inspector by my side. I discovered that while the cerebellum was quite sound the anterior lobes of the cerebrum were intensely con-

gested with blood, and had undergone previous disease. I found the anterior cerebral ganglia specially involved, and from the whole of this dumb but forcible evidence, I learned that the man was insane, that he had been insane before this time, that his insanity had taken the impulsive character, and that in a fit of extreme and uncontrollable impulse, he had committed suicide by throwing himself under the train. When the facts of this man's life were brought out before the coroner, Dr. Lankester, they gave the same evidence to the letter, nor less nor more.

In the heat of battle it is not the cerebrum but the cerebellum which propels the man on; in the chase in the race it is the same. The vehement tendency to rush forward, which nearly all persons feel when they look over a deep precipice, is of the same nature. The cerebral ganglia, overcome by the impression made upon them, are, for the moment, deprived of power, and the cerebellum, acting with sudden and uncontrolled force, gives the initiative propulsive start towards what is sometimes a deadly fall. But I must cease. If in the physics of the brain I have shown that some things, deeply interesting in their social as well as their physiological meanings, are known, what have I not unintentionally shadowed forth of that which has yet to be discovered, by the bold, the diligent, the truthful disciple of nature? Who shall show how the imagery of the brain is physically cast; who shall disclose that imagery as a world to be visibly seen? Yet in the days to come even these things, simple as known as wonderful when unknown, shall be revealed.

REVIEWS.

THE SCIENCE OF SOUND.*

THOSE who witnessed the admirable series of experiments given by Professor Tyndall, in his late course of lectures on Sound, will be glad to learn that the facts and theories then brought under their notice have been reproduced in a work whose method, as a scientific handbook, is only excelled by the grace and terseness of its literary style, and the clearness and abundance of its illustrations. Very few of us have paid attention to the science of acoustics, and the reason of this is, we apprehend, the circumstance that our teachers, through ignorance or design, have universally passed the subject over as one of little interest, and of still less scientific importance. Even a cursory glance at Dr. Tyndall's book will convince the student that a splendid field of research and experiment has been left unnoticed by writers on Natural Philosophy. The phenomena of Sound offer for solution some of the most complex problems which the whole range of physics present; and the laws which regulate them, display an order and correlation unsurpassed in any department of Natural Science. The author of the present work does not pretend to offer many original views upon the facts of Sound-Science, his object having been rather to bring together all that is known concerning the laws which regulate vibration, and to discuss the curious facts connected therewith, which have been recorded by various continental writers. This he has done most thoroughly, and, in addition, he has brought his own powers, as our greatest and most successful experimenter, to illustrate theories which without this aid would have been difficult of comprehension to ordinary readers. As performed in the lectures, some of the author's experiments had the rare quality of bringing conviction home to the minds of his pupils: as gone through on paper, in the book before us, they have lost little of their original force. The woodcuts intercalated in the text are so numerous and well executed, and the explanations are so lucid and forcible, that no well-educated man can fail to make himself acquainted with acoustics, if he has a real desire to learn. The book is divided into eight chapters, in accordance with the number of lectures originally delivered, and each chapter is followed by a summary, which will be found useful by the student, whom it enables, in a brief space of time, to travel over ground whose features might be otherwise forgotten. We have

* "Sound." A Series of Eight Lectures, delivered at the Royal Institution of Great Britain. By John Tyndall, LL.D., F.R.S. London: Longmans. 1867.

not space for an analysis of the contents, but we may offer a few of the headings of the chapters, as indicative of the wide range of subjects discussed:—Nature of sound, its propagation; Newton's and Laplace's formulæ; influence of heat, density, and elasticity; vibration of sound in various bodies; distinction between music and noise; periodic and unperiodic impulses; vibration of tuning-fork; the syren; wave-lengths of the human voice; vibration of strings; sound-boards; nodes and ventral segments; timbre; overtones; clang-tint; special harmonics and their abolition; vibrations of rods; kaleidophone; musical box; harmonica; disks and bells; longitudinal vibration of wires; vibration of pipes, stopped and open; resonance reeds; the organs of voice; sounding and sensitive flames, &c.; vibratory motions in water and air; destruction of sound by sound; theory of beats; optical illustration; resultant tones; combination of musical sounds; theories of consonance and dissonance; interference of primary tones and overtones; musical chords; mechanism of hearing, etc. Those above all who are interested in music, and desire to appreciate the cause of the singular effects so well known to musicians, should read Dr. Tyndall's volume, in which they will find a veritable mine of wonderful facts. The description of the Syren alone is a dissertation on the theory of music. For clearness of diction, and simplicity of explanation, this book stands unmatched. It is the best popular treatise on sound ever published, and it is withal the most comprehensive and accurate student's handbook on the science of acoustics.

ASTRONOMICAL HETERODOXY.*

OUR readers, of course, accept the ordinary doctrine of astronomers, that the earth moves round the sun: indeed, we are disposed to think that many would resent any attempt to turn their faith on this point as a piece of insanity. There are few of us so calm as the metaphysician who alleged that if a man bearing a reputation for common sense came to him and said that two and two make five, and not four, he would listen to him and hear his arguments. But, after all, the acceptance of a faith, no matter how general or implicit it be, is no criterion of its soundness. It must be remembered that when it was first asserted that the earth moves round the sun, and not the sun round the earth, the assertion was not only listened to with doubt, but was rejected with derision. Besides, it must be confessed that the demonstration of the absolute movement of the earth round the sun is by no means the easiest matter in astronomy. To prove a relative movement is no difficult task; but to decide which of the two, the sun or the earth, is the fixed and which the moving body, is a problem which is certainly none of the simplest. The author of the brochure before us, tries to show not only that this is difficult; but that it is impossible. He does not deny for a moment the fact of a relative movement of the sun and earth; but he contends that there is no mathematical evidence to prove that it is the earth, and not the sun, which performs the orbital circuit. The arguments he adduces to show the fallacy of our present proofs are both numerous and

* "The Theories of Ptolemy and Copernicus." By A Wrangler. London: Longmans. 1867.

powerful ; but at the same time, while they show that the author has given serious attention to the question, they give us the idea rather of the "special pleader" than of one in search of truth. We, however, have no right to enquire into motives. The chief evidence in support of the current doctrine, is that which relates to Newton's law of the gravitation of masses, to aberration, and to parallax. The value of each of these is discussed by A Wrangler, and, in his opinion, "found wanting." The law of gravitation he objects to on the ground that it is in great measure an hypothesis, since we cannot tell what may be the peculiar constitution of the heavenly bodies, and cannot therefore infer how gravity may act in each particular case: for it must be stated that A Wrangler has a pet hypothesis of his own, to the effect that the specific force of gravity may be different for different substances. Aberration is, in his opinion, useless, because he thinks that it may be explained upon either supposition—that the earth moves round the sun, or the sun round the earth. Parallax is, he considers, equally unreliable, because it depends for correction on aberration ; and thus he annihilates all the testimony in which our poor credulous philosophers have been relying for so long a period. What, then, the reader will inquire, is the ultimate conclusion of this Iconoclast ? We answer, none : he is merely an intelligent sceptic, who says you believe too much, for there are no logical grounds for your belief. We cannot afford the space to meet A Wrangler seriatim on all the points which he has raised ; but even admitting the possibility of both parallax and aberration being explicable on either hypothesis, we can fall back on Newton's grand law, which A Wrangler has done nothing whatever to disprove, and we can say that it at once removes all of those doubts which the peculiarities of parallax and aberration tend, we confess, to engender. The way in which Sir John Herschel lays down the evidence on this grave question is characteristically lucid, and we cannot do better than refer our readers to the first chapter of his "Outlines," for a simple and convincing expression of the evidence in support of the Copernican doctrine. In concluding his 77th paragraph, where he refers to the deficiencies of the testimony, he observes : "The Newtonian theory of gravitation supplies this deficiency, and by showing that all the motions required by the Copernican conception *must*, and that no others can, result from a single intelligible and very simple dynamical law, has given a degree of certainty to this conception as a matter of fact, which attaches to no other creation of the human mind." A Wrangler has failed to shake our belief in Newton's law, since he has done nothing to show that the principle of gravitation is not universal ; and so long as we accept this law, so long must we give our faith, so far, to the system of Copernicus.

MUSHROOMS AND TOADSTOOLS.*

MUSHROOM-EATING humanity owes a never-ending debt of gratitude to Mr. W. G. Smith for the admirable work which he has just given

* "Mushrooms and Toadstools: how to Distinguish easily the Difference between Edible and Poisonous Fungi." With two large sheets, containing coloured figures of 29 edible and 31 poisonous species. By Worthington G. Smith. London: Hardwicke. 1867.

it. Henceforth, assuredly, accidental poisoning by fungi should be made penal, for with the assistance of the beautiful plates and the excellent little volume before us, no such cases need occur. The author has spent a considerable portion of his life in the study of our larger fungi; and his attention has not been confined to their botanical properties, but has been freely—indeed, in some instances, too freely—given to the consideration of their dietetic qualities. By this means he has acquired a fund of information, and a combination of different varieties of facts, such as no other English fungologist can be asserted to possess. This union of the structural and toxicological methods of investigating the larger fungi is just what was wanted by those who desired to extend the list of edible mushrooms beyond the one or two species now eaten. No better instructor, therefore, than Mr. Smith could be found, and with him as our guide we may fearlessly and agreeably indulge in fungidishes, which to the less initiated might appear not only unwholesome but even dangerous. The botanical or the gastronomic test, taken separately, is almost useless; but in combination they are unassailable and trustworthy. We should be loath to eat a mushroom with which we were unacquainted solely because the botanist assured us, *à priori*, that its structure guaranteed its wholesomeness. In like manner, we should doubt even the man who, though ignorant of its structure, asserted from his general experience the good qualities of a fungus, for we should very naturally say to ourselves, this fungus may resemble those which he has frequently eaten, yet may be poisonous, for he knows nothing of its structure, and mere outward resemblances are deceptive. But in the case of our author it is different. Every fungus which he states to be wholesome food he himself has eaten over and again; and of the action of the poisonous species he speaks with an equal, though more painful, certainty, for on more than one occasion he narrowly escaped death through his gastronomic experiments. Of the plates which accompany Mr. Smith's book it would be difficult to speak too highly. They constitute two large sheets, about 36 by 18 inches each, one being devoted to the poisonous and the other to the edible species. On these all the fungi are figured, of life-size and in the natural colour. We perceive, too, that the position of each has been so arranged that the mode of construction of the gills—a very important point in diagnosis—is distinctly shown. Whether we look upon these illustrations as the creations of the highest artistic skill, or as the expression of the most thorough botanical knowledge, we are compelled to confess that they are typical of excellence: they cannot be surpassed in beauty or fidelity. For the purpose of field work they are made (in a special edition) to fold and unfold like a map, so that they may be carried in the pocket, and employed, *sur place*, in the process of identification. The author's introductory observations suggest many important points to the amateur fungologist; and though they can hardly be styled scientific, they contain no inaccuracies. So far as the writer goes his statements are correct, and his remarks on fungus cookery we dare not pretend to criticise. We have derived both pleasure and profit from the perusal of this work, and as we desire to see it as perfect as possible, we would offer a few suggestions to the author, which we trust he may adopt in the first of the many editions his work is likely to pass through. There are two points in which we think Mr. Smith might add to the value and im-

portance of his book: (1) by giving an analytical key—like Mr. Bentham's scheme for the identification of phanerogams—with the assistance of which the student could with safety refer a specimen to its species; and (2) by stating in *every* case the exact period of the year at which each species may be found. According to the existing arrangement, the mushroom-hunter, having found a specimen which he desires to investigate, is either obliged to read the description of various species till he hits upon the proper one, or else has to search through both plates till he has found some illustration which corresponds to the specimen in question. This is all well enough for those who are incapable of grasping minute details of structure, and who therefore deserve to submit to the penalty of delay; but some more perfect provision should be made for the better class of student. With reference to the second point, the deficiency can easily be met, and we think it is important that it should be provided against. We notice various species whose habits and character have been clearly stated by the author, but whose seasons of growth have not been mentioned. Of these the following are a few:—the variable mushroom, the furrowed clavaria, the chantarelle, the fir-cone mushroom, the orange-milk mushroom, the purple cobweb mushroom, the curled helvella, &c., which are edible. The same may be said of the poisonous mushrooms. We dwell upon this point of season because it not only is of interest to those who may wish to seek a particular specimen, but because it appears to us the knowledge of the period at which a particular species of fungus appears may be of value to the student when he finds a difficulty in referring a specimen to its proper place, &c. The collateral information which Mr. Smith lays before his readers is curious, and will not a little astonish some Londoners. Those who derive their supply of mushrooms from Covent Garden Market, and who fancy that they obtain the common mushroom, *Agaricus campestris*, will be surprised to learn that the species supplied to them is what is known as the horse-mushroom, *A. arvensis*. The latter not unfrequently is found growing with the former, and is often mistaken for it; nevertheless, it is usually larger, coarser, and possesses a less delicious flavour. The top, in perfect specimens, is smooth and snowy white; the gills are not the pure pink of the meadow-mushroom, but are of a dirty brownish white, which changes to black; its stem is disposed to be hollow, and is surrounded by a large ragged "floccose" ring. Now, this species is almost the only one to be seen in Covent Garden Market. "Indeed," says Mr. Smith, "after knowing the market for many years, I have rarely seen any other species there; when the true mushroom, however, is there, it is frequently mingled with horse-mushrooms, which seems to show that the dealers do not know one from the other. In the wet days of autumn, children, idlers, and others go a few miles from town into the meadows to gather whatever they can find in the mushroom line. They then bring their daily stock to market, where it is sold to fashionable purchasers, stale, vapid, and without taste—unless it be a bad one." Our author's general remarks on each of the species are as interesting as those we have quoted, and they have afforded us a good deal of agreeable reading. The fungus season is now almost at its height, and we advise all who are interested—*gourmets* and fungologists—to make Mr. Smith's book their field companion. We can say nothing more favourable of his plates than that they are likely to be productive of very delicious dishes.

A POPULAR FERN BOOK.*

WE have been so inundated during the last few years with books on Ferns, that we felt at first disposed to be angry with Mr. Cooke for providing us with another treatise. The work, however, is so good a one, and its price is so low, that we welcome it as a means of spreading a taste for a branch of botany, which, though much cultivated, is by no means exhausted. There is, too, a completeness about this little volume which gives it a superiority over some others of its class. No question connected with ferns is left unanswered in its pages, unless it be the question of distribution, which, in our opinion, has hardly received as much attention as the author might have given it. But, perhaps, in a popular treatise, this point is not of much importance. After all, the chief requirements of the botanist are, a knowledge of the natural history of the class he is about to study, and a clear and accurate account of those structural characters by which the several species may be identified. In these respects there is nothing wanting in Mr. Cooke's little volume. The titles of the introductory chapters give a good idea of the subject-matter of the book. They are as follows:—General properties and uses of ferns; Structure; How to grow ferns; Pests and parasites (a point on which the author is one of our highest authorities); How to form an herbarium; classification. Then comes the description of the various species, the common name being given above, and the scientific description being placed in a foot-note. The author's classification is a convenient one, and, so far as we can perceive, there need be no difficulty in its employment. He divides all ferns into two primary groups; those in which the spore cases are deprived of a ring—Exannulate, and those in which a ring is present—Annulate. The former include the *Osmunda*, Moonwort, and Adder's-tongue; the latter contains two subdivisions, those in which the ring is oblique embracing the filmy ferns and the *Trichomanes*, and those in which it is circular including all the other species. The other groups are based on the character of the spore tufts and their covers. This classification is not merely convenient, it is eminently a natural one, since it brings together the *Hymenophyllum* and Killarney ferns, which all who are familiar with them must admit to be very near relations. The particular to which we object in this work is that to which we have already called attention, viz. that of distribution. More stations might, we think, have been given. This is especially true in regard to the distribution in Ireland, the Maiden-hair being the only rare fern whose "stations" in the sister island are fully given. The statement which Mr. Cooke quotes, from the "Proceedings of the Dublin Natural History Society," is perfectly correct. We have ourselves seen the Maidenhair covering the sea-cliffs of Clare and the islands of Arran, and growing as luxuriantly as the royal fern at Killarney. Both the filmy ferns may be found in great abundance in Killarney, especially in the neighbourhood of O'Sullivan's Cascade, where they grow to a size which prevents even an ordinary passer-by mistaking them for mosses. In addition to the distinction between the two species, *H. Wilsoni* and *H. Tunbridgensis*, given by the

* "A Fern Book for Everybody." By M. C. Cooke. London: Frederick Warne & Co. 1867.

author, may be mentioned the fact, pointed out first by Professor Gulliver, that in one species the cells are considerably larger than the other, a point which even a good Coddington lens enables one readily to discover. The statement that the Sea-spleenwort is only to be found on the south-west coast (England), must be accepted with some qualification. We have found it in great abundance in various parts of the south-east of Ireland. The illustrations to Mr. Cooke's book are divided between the plates and the text, and are carefully executed.

BRITISH CONCHOLOGY.*

IN this the fourth volume of his *British Conchology*, Mr. Jeffreys continues his description of the Marine Gastropoda, commencing it with the genus *Rissoa*, and bringing it down to the genus *Bulla*. Of the general plan of the work we have spoken in our notice of the earlier volumes; we need only say, therefore, that in the present instance the general scheme has been carried out fully and faithfully. The genera described are in all cases as comprehensively treated as the most earnest conchologist can desire, and the accessory details are such as are not always to be found in systematic works on the mollusca, unless indeed in the splendid treatise of Forbes and Hanley. The plates in the volume now issued are nine in number; the first one, which forms a frontispiece, being an exquisite, coloured representation of the singular *Ianthina*, and the remaining eight being carefully-drawn sketches by Sowerby, of the genera referred to in the text. The table of geographical distinctions shows the different areas of the recent and fossil gastropods, and is valuable for purposes of reference. As a specimen of how the author deals with a genus, we should wish our readers to take up his description of *Ianthina*; this, which relates to all points in the natural history of this singular creature, extends over nearly fifteen pages, and is a miniature monograph literally crammed with facts; so well has the author condensed his observations. The fifth volume will complete the work, and will contain an account of the remaining Pleurobranches, the Nudibranches (by Mr. Alder), the marine Pulmonobranches, the Pteropods, and the Cephalopods. It will also include a supplement and a series of plates, plain and coloured, depicting all the species and remarkable varieties of British shells. When completed, the work will be the most complete and compact treatise in our language.

GOLDING BIRD'S NATURAL PHILOSOPHY.†

THE old friend of our student days, our companion in the lecture-room and the physical laboratory, is about to undergo a change of name, in fact, has

* "*British Conchology; or, an Account of the Mollusca which now inhabit the British Isles and the surrounding Seas.*" Vol. IV. *Marine Shells.* By J. Gwyn Jeffreys, F.R.S., F.G.S. London: Van Voorst. 1867.

† "*The Elements of Natural Philosophy; or an Introduction to the Study of the Physical Sciences.*" By Charles Brooke, M.A., F.R.S. Based on the

undergone it. The "Golding Bird," as we used to term it at College, is no longer to be Golding Bird, but Brooke. The change is but a just one. The science of Bird's time has passed, like Bird himself, from among us, and the writer who has successfully carried the work through so many editions, and has so thoroughly altered its matter, is, in truth, the author. It is not too much to say of the volume before us that it is virtually Mr. Brooke's composition. A wonderful book it is, too. Doubtless there are defects, but there are very few treatises which include every department of that terribly wide science, Physics, which can boast fewer errors or omissions. Extending as it does over nearly 900 pages of small print, containing more than 700 woodcuts, and dealing with Mechanics, Hydrostatics, Pneumatics, Sound, Magnetism, Electricity, Light, and Heat, in regard to both their principles and ancient and modern application, this manual is a model of careful compilation. It treats of every question in Natural Philosophy which can be discussed without reference to "mathematical physics," and thus forms an excellent textbook for the student, while its clear description of philosophical apparatus, and its embodiment of the most recent results of physical research, render it a useful book of reference for the man of education. We think Mr. Brooke has spared no pains to seek out the most novel applications of science for description in his work, and that his efforts have been decidedly successful. In all that relates to the recent physical discoveries—such as, for example, Wilde and Siemen's electro-magnetic machines, Brown-ing's spectroscope, Powell and Lealand's binocular—for high powers, and so forth, this manual gives complete details. There is only one feature we find fault with, and that is part of the introduction. Why did Mr. Brooke indulge in a discussion of the moral aspects of Physics? His observations, though well intended, are as out of place as they are petulant and illogical. We allude to the remarks, and not to the aim which prompted them.

THE FIELD-NATURALIST'S COMPANION.*

HERE is a little book *sui generis*. We know of no other of its kind. Translated from the German of Nave, by the Rev. W. Spicer, a naturalist well qualified for the task, it tells us how we may search for, when we may find, how we may preserve, and in what manner we may prepare, all the cryptogamic beauties which lie in myriads round us, but which so few of us know aught of. Those who have got a microscope, and wish to spend a twelvemonth of pleasant "evenings" at it, should procure this "handy-book" and begin their excursions. The author will tell them how to provide themselves in order to carry on their labours to advantage. We doubt whether one requires all the apparatus which Herr Nave describes; but we

treatise of the late Golding Bird, M.A. Sixth edition. London: Churchill. 1867.

* "A Handy-book to the Collection and Preparation of Fresh-water and Marine Algae, Diatoms, Desmids, Fungi, Lichens, Mosses, etc." By Johann Nave. Translated and Edited by the Rev. W. Spicer, M.A. London: Hardwicke. 1867.

suppose that he considers his book would have been incomplete did not all the paraphernalia of the field-naturalist find a place in his volume. But whatever view our readers may take on this point, we can assure them that they will find all the information they require in Herr Nave's Handy-book, and what the text may be deficient in, will be met by the twenty-six excellent page-plates which are dispersed through the letterpress. The editor's notes, though they are not numerous, are concise and useful. The publisher, it seems to us, would have consulted the convenience of readers more, had he distributed the illustrations over the text, instead of grouping them in plates. What is gained in beauty by the better working of cuts when printed in plates, is lost in time to the student, who is obliged to turn over leaves oftener than he requires in order to find the figure to which what he is reading refers. This is the only point which, in our opinion, needs amendment, and, after all, it is not a very serious one.

SANTORIN: A VOLCANIC CRATER.*

THE islands of the Santorin group have for many years attracted the attention of those geologists who sought to discover the origin of volcanoes—who tried to solve the problem of the construction of craters. Since the recent eruption, so fully detailed in these pages by Professor Ansted, Santorin has had many European visitors, especially French and German. These have not only carefully investigated the topographical features of its islands, but have brought the most subtle instruments of science to bear upon the volcanic phenomena, in order to arrive, if possible, at the conditions which govern eruptive discharges. Magnetism has been especially employed, and has given some startling results. It will be understood, therefore, that those islands are objects of the highest interest to the philosophic geologist, who hopes by a careful study of them to unfold the now mysterious laws controlling the development of volcanoes. The work which Messrs. Trübner have issued in an English dress comes in good time, and though its text is neither particularly original nor comprehensively embracing, it is suggestive, and the admirable photographs which accompany it are invaluable to those who would study this singular series of islands. These photographs are birdseye views of the Kaimeni (or burnt islands), and having been taken from carefully-prepared models, they give an excellent idea of the outline and general conformation of the rocks. The maps, too, show at a glance that the islands of Santorin, Thera, and Therasia are really but portions of a gigantic crater, the remainder of which is now submerged. This is the opinion held by the authors, and expressed in somewhat stilted and Germanised English in the work before us. "The semicircular island of Thera, which, with Therasia and Aspronisi, encloses a sea-basin of more than five miles in diameter, containing in its centre three islands of historical date, the Kaimenis (or burnt islands), resemble com-

* "Santorin. The Kaimeni Islands, from Observations by K. v. Kritsch, W. Reiss, and A. Stübel." Translated from the German. London: Trübner. 1867.

pletely the most celebrated volcanoes of Europe, and many of the American continent, as well with regard to its internal structure as concerning its relation to the modern eruptions. There exists between Thera and the Kaimeni islands the same relation as between Somma and Mount Vesuvius—between the Serra di Fogo and a wider cone of 9,000 feet—a relation which we find again recurring between the Pic of Tenerif and the Cañadas mountains, by which it is surrounded." This opinion is supported by many analogies, and is doubtless correct; but it is not original, having been long ago pronounced by the great geologist, Von Buch, who looked upon the whole crater as one of "elevation" rather than of deposition. No one who has read the history of the late eruption, and who glances at the photographs and maps of Messrs. Reiss and Stübel's work, can fail to be impressed with the belief that Kaimeni stands in the same relation to Thera and the surrounding islands as Vesuvius does to the Somma; that is to say, it is the modern and active eruptive centre, situate within the ancient and extinct eruptive centre which surrounds it. The maps have been prepared upon the plan of those published by our Admiralty, but have been drawn to a considerably larger scale, and help to clear up the ideas suggested by the photographs. We have much pleasure in commending this work to the notice of our geological readers.

MEDICAL BIOGRAPHY.*

THE work, which was begun in 1865 by the late Dr. Herbert Barker, is being continued by his friend, Dr. Tindall Robertson. Its object is to present the public with a series of photographs of the more celebrated physicians and surgeons of this and other countries, accompanied by short sketches of the various incidents which have characterised their lives. We regret that we can only speak from our experience of a single number, but, in so far as our own judgment goes, the editor and photographers have discharged their respective duties with credit to themselves and satisfaction to their subscribers. Dr. Robertson appears to show no partiality either in the selection of his biographical subjects or in his method of treating them. The examples chosen in the number before us,—Drs. William Augustus Grey, Robert Gardiner Hill, and Mr. R. W. Dunn,—are all distinguished members of the profession; and the history of the successive labours by which they raised themselves from mediocrity to fame, has been truly and pleasantly given by the editor. Dr. Robertson avoids, as far as possible, those laudatory digressions in which so many biographers indulge, and endeavours to state facts without giving them more than their natural colours. In this he has been successful, and the result is therefore eminently satisfactory. In the pages of this work readers will find all the important facts in the history of our "eminent medical men" stated with clearness, accuracy, and

* "Photographs of Eminent Medical Men of all Countries, with Analytical Notices of their Works." No. 5, Vol. II. London: Churchill.

honesty; and when they turn from the letterpress to Mr. Ernest Edwards' excellent photographs, they can put the seal of association upon the facts they have gathered from Dr. Robertson's ably-written memoirs.

THE CONSTELLATION SEASONS.*

MR. PROCTOR here gives us a series of thirteen carefully-drawn maps, representing the relative position of the various constellations for nearly every night in the year. These maps do not, of course, contain all those astronomical details which are to be found in a perfect star-map. Such details would have been out of place; the object of the author being to supply the amateur astronomer with a picture of the heavens at certain hours, so that he may study the more important star-groups. Each map contains the whole of the visible heavens at the hour and date mentioned beneath it, the centre being the point over the head of the observer, and the outline indicating the horizon. Each star is marked in its proper direction as regards the point of the compass, and is placed at its true geographical distance from the centre. Hence the student commencing observations at the hour and date of the map, soon makes himself familiar with all the constellations. The maps include stars of the fourth magnitude, and by an easy calculation they may be employed for other nights than those for which they are intended. In our early studies of the constellations we had only the assistance of Lardner maps, and we can therefore fully appreciate the value of Mr. Proctor's excellent series.

HOW TO MAKE A STEAM-ENGINE.†

WE remember that one of the earliest and one of the most cherished ambitions of boyhood was the construction of a model steam-engine. This desire is by no means an uncommon one, and may, we believe, be classed with that all-pervading fancy of some boys, that to be a sailor is to enjoy the very acme of mortal happiness. The little book before us is intended to supply ambitious youth with the information necessary to understand a working locomotive, and to manufacture a model steam-engine. The elementary sketch of the history of the discovery of steam as a motive power is simple and tolerably free from error, but we fear that boys will find it difficult to understand a "stoker's" explanation of the principle on which "Barker's mill" revolves. To say that the rotation is dependent on "the well-known principle in mechanics that action and reaction are equal and in contrary direction," is simply to put a stumbling-block in the young reader's path. It is even worse, for it is no explanation

* "The Constellation Seasons: an Easy Guide to the Knowledge of the Stars." Edited by Richard A. Proctor, B.A., F.R.G.S. London: Longmans. 1867.

† "The Model Steam Engine: How to Buy, How to Use, and How to Make it." By a Steady Stoker. London: Houlston & Wright. 1867.

at all, the key to the movement being the inequality of pressures. The description of the method of making a model steam-engine, however simple it may seem to a stoker, could not be followed even by a boy who possessed considerable mechanical skill. We think, therefore, that however laudable the aim of this little work, the author has failed completely in its execution.

ARITHMETIC SIMPLIFIED.*

THE four rules of simple arithmetic, and vulgar and decimal fractions, are dealt with most intelligently by the author. The book is intended as a supplement to Dr. Arnott's treatise on Physics, and for the use, not of beginners, but of those who have in some measure forgotten what they have learned. We know a good many well-educated people who cannot, nevertheless, add together half-a-dozen vulgar fractions, and to whom a decimal fraction is somewhat of a mystery; to those we commend this volume. It is very simple and intelligible.

WEATHER SCIENCE.†

OF the degeneration of weather-students since the death of Admiral Fitzroy, we have ample proof in the abundance of works like the present one which come under our notice. In the book upon our table we find a number of papers, some with authors' names and some without, but all expressive of the ignorant dogmatism and flippant presumption which are characteristic of senility in its most intolerable stage. The intense impertinence and utter superficiality of their composition is evinced in the following quotation from a paper by a lady whom an adoring editor styles the "pioneer of modern physical astronomy:"—"When good sense has banished pedantry, and astronomy details celestial movement according to *fact*, the noble simplicity of the science will become apparent; and the object of most of the phenomena within our solar system will form one and the same with the actuating principle of the universe—viz., the *accumulation of renovating reproductiveness*. The planets then, ceasing to be considered as mere retrograding or stationary puppets, will be registered as independent orbs in the constant interchange of mutual renovations." We pause in astonishment to think what would become of Miss Burton's "accumulation of renovating reproductiveness," were common sense even now to banish pedantry. There must indeed be a "noble simplicity" of mind in those who, like our editor, can believe in such disgusting and inane verbiage as the above. There is only one word in our language which expresses its value, and that word is Rubbish!

HANDBOOK OF PRACTICAL TELEGRAPHY.‡

IN our notice of the first edition of this work we spoke in favourable terms of the method pursued by the author in the treatment of his subject.

* "Arithmetic Simplified." By Neil Arnott, M.D., F.R.S. London: Longmans. 1867.

† "The Science of the Weather; in a Series of Letters by several Authors." Edited by B. Glasgow: Laidlaw. 1867.

‡ "A Handbook of Practical Telegraphy." By R. S. Culley. Second edition. Longmans. 1867.

In the present edition we perceive that many new features have been introduced, and that the book has been considerably enlarged. Dealing as it does with the construction of the different varieties of telegraph, and with the most approved means of constructing lines and supplying galvanic force, it is a work which must be especially valuable to electric enquirers and telegraph superintendents. It will be found the textbook of reference, indeed the only one, on its subject.

Reliquæ Aquitanicæ, Contributions to the Archæology and Palæontology of Perigord. By Edouard Lartet and Henry Christy. Part IV. London: Baillière. 1867.—This number reached us too late for notice in our last issue. Like the former, it is edited by Professor Rupert Jones. It continues the subject dealt with in No. III., and treats also of the geology of Vézère. The woodcuts in the text are good, and the plates, six in number, are admirable works of art. They are brought out in Paris by Louveau and Becquet, and surpass in excellence illustrations produced in this country.

The American Naturalist. Essex Institute, Salem, U.S.A.—Of this monthly periodical we have received the numbers from March to August, with the exception of that for May. It is a new venture, devoted to the interests of General Natural History, and is creditable alike to its editor and publisher. The papers, though not upon strikingly original questions, are of much popular interest, and are, we perceive, written with a due avoidance of technicalities. The illustrations to the paper on Polyzoa and Jelly-fishes are accurately and artistically executed; the plate accompanying Dr. Packard's article on the Dragonfly being a perfect type of Natural History drawing. The reviews are written with care, and display a thorough impartiality. We welcome our new contemporary, and we hope to profit by his gleanings from the vast American fields of Natural Science.

Clinical Lectures on Diseases of the Skin. By Balmanno Squire, M.B., F.L.S. London: Churchill. 1867.—Mr. Squire is issuing a new and larger edition of his valuable photographs of skin diseases. The work will be completed in thirty-six monthly parts, and the first four numbers are now before us. Each photograph is coloured, and refers to a particular case, typical of the disease it represents, and is accompanied by two pages of letterpress, which give the clinical history of the affection. For ourselves, we are disposed to think that the uncoloured photograph is more useful than the coloured one, and infinitely more reliable, but doubtless on this point we are at issue with most dermatologists. The series is, in any case, most creditable to the author, and will be equally servicable to the physician.

We have received Readwin's Index to Mineralogy. Spon.—Summary Notes of Vegetable Anatomy and Physiology. By Louis C. Miall. Simpkin & Co.—Causes of Motion in Matter. By Thomas Ayers. Simpkin.—The Quadrature and Rectification of the Circle. By James Smith, Esq. Liverpool: Howell.—The Alleged Hydrothermal Origin of Rocks. By D. Forbes, F.R.S.—The Development and Succession of Teeth in the Mammalia. By W. H. Flower, F.R.S.—Remarks on the Genus *Pyrula*. By T. Graham Ponton.—On the Change in the Obliquity of the Ecliptic, and its Effects. By James Croll, Esq.—A Technical Institution for Leeds. By G. N. & A. Nussey.—The Akasga Bean. By Dr. T. R. Fraser, F.R.S.E.

SCIENTIFIC SUMMARY.

ASTRONOMY.

THE *Meteors of the 10th of August, 1867.*—The observations which were made at Rome have been reported to the French Academy, in a paper communicated by Father Secchi on the 2nd of September. The author regrets that his observations are not so complete as they might have been, owing to the fact that the epidemic of cholera caused many of his assistants to leave Rome. The following are the results arrived at when the Moon's light was sufficiently dim to allow observations to be made :—

August 11th.	h.	m.	to	h.	m.	Number of meteors.
	2	11	„	2	25	15
	2	25	„	2	46	16
	2	46	„	3	00	15
	3	00	„	3	20	21
	3	20	„	3	30	8
	3	30	„	3	45	11

Thus 86 meteors were seen in ninety-four minutes. On the following day the numbers were as follows :—

	h.	m.	to	h.	m.	Number of meteors.
	3	15	„	3	30	15
	3	30	„	3	45	11
	3	30(?)	„	3	46	3

“Thus, there were 29 meteors observed in thirty-one minutes.” The hourly numbers of the two days were respectively 54·9 and 42·6. The meteors seemed to radiate from the space between Perseus and Cassiopeia, but many of them were sporadic.

A Stellar Spectroscope of extreme simplicity, and which may be adapted to any ordinary telescope, has been devised by Signor Secchi. Amateurs may henceforth, therefore, pursue spectroscopic investigation of the stars with a considerable degree of accuracy. The combination he has devised consists of a prism and cylindrical lens, and forms a spectroscopic eyepiece. M. Secretan adapted it to a telescope with an aperture of only 95 millimetres, and with this arrangement Signor Secchi was able to observe and examine the principal spectral bands of stars of the 1st and 2nd magnitude. α -Herculis and β -Pegasus were examined with ease, and the atmospheric rays of the planet Jupiter were clearly seen.

The August Meteors have also been examined by MM. Coulvier-Gravier and Chapelas, who have come to a different conclusion to that of M. Secchi as to their relative number in this and in former years. These observers

gave the result of their observations on the shooting-stars during the nights of the 9th, 10th, and 11th of August of this year. They showed, by a tabular statement, that from the 5th of August, the mean hourly number at midnight in a clear sky—that is to say, corrected for the lunar light and the presence of clouds—was 16·2 stars; this became 33·7 on the 9th, 49·9 on the 10th, and 28·7 on the 11th, giving an average of 37·4. Comparing this with the year 1848, which had given, for the mean hourly number, 110 meteors, it seems that the quantity diminishes very sensibly.

Behaviour of the Aneroid Barometer.—On this subject a very valuable paper was read by Dr. Balfour Stewart at the recent meeting of the British Association in Dundee. Experiments had lately been made with the view of ascertaining to what extent an aneroid may be considered a reliable instrument when exposed to considerable changes of pressure, such as occur in mountain districts. By means of an air-pump, the aneroids, when placed in a receiver, may be subjected to any pressure. A method of tapping the aneroids had also been devised, and by this means the experiments as to the deviation of the results given by these instruments were conducted with comparative ease, and with the greatest accuracy. The experiments are still going on. Sir William Thomson, in commenting on Dr. Stewart's communication, said the aneroid had become so popular an instrument, that many had satisfaction in learning that it was capable of giving results with scientific precision. Dr. Stewart had shown that in taking a barometer up a mountain of 12,000 feet, the error would only be about 300 feet, and had also shown how to correct this error. By carefully using these instruments, therefore, they had a probability of determining, with much less probability of error, the height of a mountain of 12,000 feet.

Lunar Maps.—Mr. Birt recently issued two lunar maps, in *red* outline, with all the present known objects marked, in order that those who find any variation in the objects may mark them in *black*. These maps, which contain 203 objects, are on a scale of 200 inches to the Moon's diameter, and comprise the space included between 0° and 6° West longitude, and 0° and 10° South latitude.

The Memoirs of the Astronomical Society.—It is stated that the Council of the Royal Astronomical Society have resolved that in future the Memoirs of the Society shall be given to all Fellows applying for them, and that this regulation will commence with the volume preparing for the current year. The subject has occupied the attention of the Council on several occasions before, but the expense was considered too great.

The Dusky-ring of Saturn.—Mr. G. F. Chambers, having made a misstatement in regard to the history of the discovery of the "dusky-ring," writes to the editor of the *Astronomical Register* to correct his mistake. The erroneous paragraph appears on page 129 of Mr. Chambers's *Descriptive Astronomy*, and is as follows:—"On December 3, Lassell, while on a visit to Dawes, saw 'something like a crape veil covering a part of the sky within the inner ring.' This observation, *it would seem, was not made in consequence of any hint given by Dawes* as to what he himself had seen, so Lassell must be regarded as a third or (reckoning Galle) a fourth independent discoverer." Mr. Chambers makes the following explanation:—"I have satisfied myself that the passage italicised is entirely the reverse of

the truth, and that Mr. Lassell has no claim to be regarded as an independent discoverer. I was misled by depending on the *Monthly Notices* of the period, and by the phraseology adopted by Mr. Lassell in communicating to the Society his account of certain observations made by him in company with Mr. Dawes."

The Lunar Crater Alhazen has often been a puzzle to selenographers, from the various appearances it has presented to observers, and from its general indistinctness. Recently, however, it has been very satisfactorily observed by Mr. W. R. Birt, F.R.A.S., who had previously (vide *Monthly Notices*, vol. xxii., p. 230) given considerable attention to the subject. In his earlier account of the appearance, Mr. Birt was unable to give a description of the crater. On the 5th of July last, however, at 9 p.m., he saw the crater under very favourable circumstances with the Royal Society's achromatic of $4\frac{1}{4}$ inches aperture, power 230, Schröter's pair of craters γ and δ in its neighbourhood being very distinct (see *Astronomical Register*, No. xliii., July 1866, p. 188). He then ascertained that Schröter's Alhazen is really a crater situated on the surface between the two ranges of mountains, and but slightly depressed below it. Although not greatly depressed, it is sufficiently so to present, under this illumination and visual angle, the *true* crater-form. It would seem, says Mr. Birt, that its apparition as a crater is *rare*, probably from a variety of causes. It is quite of sufficient magnitude to have been seen with an aperture of $2\frac{1}{4}$ inches, and it would be very important to ascertain if, under *nearly* similar circumstances to those of July 5, 1867, it would present a similar aspect. "The selenographical conditions of its visibility on July 5 were as follows:—Morning illumination, after Perigee, 102 hours; before Apogee, 215 hours. Eastward of its mean position in longitude, Moon's latitude, S. $0^{\circ} 43' 55''$, a little southward of its mean position in latitude. For illumination, longitude of termination, W. $42^{\circ} 12' 54''$, angle of terminator and meridian— $1^{\circ} 23'$. South pole of the Moon in sunlight 25 days after the winter solstice in the Moon's northern hemisphere."

Newly-discovered Comes of Vega.—An observer (R.C.) states that Mr. Buckingham, of Walworth Common, has discovered two new comes, much closer than those so well known to astronomers. R. C., who ought to have given his name in full, states that, on being asked by Mr. Buckingham to examine Alpha Lyra, and in turning the telescope to the star, he saw one of the stars which Mr. Buckingham had already discovered, and described the position and the distance by comparison with the known distance of the companion-star, fixing it at five or six seconds. These data coincided with Mr. Buckingham's. But, owing to the fitful and unsteady atmosphere, it was some time before he was able to catch up the *second* companion, which seemed fainter and somewhat more distant. He believes that Mr. Buckingham first discovered these two companions with his 20-inch refractor, and was able afterwards to verify his discovery with the 9-inch equatorial in which he saw them; but, though he recorded the fact at the time, he did not publish his discovery. As he was also able to see the companions clearly, and tested the sight by turning consecutively half-round the eyepiece and object-glass with the same result, and as he has no doubt possessors of similar telescopes will be able to make them out easily, it seemed

to him that a discovery of such a system attending Vega should be made known, as of course it would be invested with an interest second to none in the list of double stars.

The total Solar Eclipse of 1863.—At the meeting of the British Association, Sir Andrew Waugh read a paper by Major Tennant, regarding the steps that are being taken by the Indian Government to ensure extensive and correct observations of the coming eclipse. The eclipse in question will be seen to great advantage, and the arrangements that were being made gave promise of valuable results. The Secretary of State had sanctioned the proposal to send out to India some of the best instruments in this country. It was intended, among other observations, to photograph the appearances presented, and for this purpose a large telescope was to be erected. Provision had been made for obtaining a considerable field of view, in order that, if possible, some record might be obtained of the structure of the corona. The Astronomer Royal had lent a 42-inch telescope, with an eyepiece, for the examination of the lines of the corona, and altogether the preparations which Major Tennant was now in London superintending led them to believe that valuable results would be obtained by the observation of this eclipse. It was stated by Mr. W. Ladd, who was present, that the arrangements of Major Tennant for the polarising eyepiece for the telescope were very simple. He had been constructing one of these for Major Tennant, and also for Mr. Huggins, and he thought that no astronomer should be without this polarising apparatus. It might be easily attached to the eyepiece of ordinary telescopes.

The Kew Photo-Heliograph.—According to the recent Report of the Kew Committee, it appears that the heliograph, which is in charge of Mr. De la Rue, continues to be worked in a most satisfactory manner. During the past year 204 negatives have been taken on 144 days. Pictures of the Pagoda in Kew Gardens are regularly taken by this instrument, in the hope that by this means the angular diameter of the Sun may be satisfactorily determined. Since the meeting of the British Association in 1863, a second series of solar researches, in continuation of the first series, has been published (the expense of printing having been defrayed by Mr. De la Rue), entitled "Researches in Solar Physics, Second Series, Area Measurements of the Sun-spots observed by Mr. Carrington during the seven years 1854-1860 inclusive, and Deductions therefrom; by Messrs. De la Rue, Stewart, and Loewy." The heliographic latitudes and longitudes of all the spots recorded by the Kew Photo-heliograph during the years 1862 and 1863 have been calculated, and it is hoped that the results may soon be published, forming a third series of Polar Researches. It is believed that these results will demonstrate the superiority of photographic pictures over all other methods of observation. The sum of £600 has been obtained from the Government Grant Fund of the Royal Society to be applied to the discussion of Hofrath Schwabe's long and valuable series of sun-spots at present in the possession of Kew Observatory. These pictures are now being examined with this object. Sun-spots continued likewise to be numbered, after the manner of Hofrath Schwabe; and a table, exhibiting the monthly groups observed at Dessau and at Kew, for the year 1863, has already appeared in the *Monthly Notices* of the Astronomical Society, vol. xxvii., No. 8.

The late Lunar Eclipse.—A partial eclipse of the Moon took place on the 13th of September. It commenced at about twenty minutes to ten. The following was the order of appearances:—

	h.	m.	
First contact with the penumbra	9	43.3	Greenwich mean time.
First contact with the shadow	10	57.4	
Middle of the eclipse	12	26.2	
Last contact with the shadow	13	55.0	
Last contact with the penumbra	15	9.1	
Magnitude of the eclipse (Moon's diameter=1), 0.693.			

Aqueous Vapour in the Stars.—M. Jansenn announces an important discovery which he has just made—viz., that in a spectrum-analysis of some of the stars, he has seen bands which indicate the presence of aqueous vapour in these bodies. He observed this especially in the case of the spectrum of Antares. In order to avoid any error through the presence of atmospheric vapour, M. Jansenn conducted his experiments at Etna, where the air is remarkably rare and dry. Researches made at Palermo and Marseilles lead him to conclude that there is water-vapour in the atmosphere of both Mars and Saturn.

The labours of the Lunar Committee have formed the subject of some interesting comments by Mr. Glaisher. The method in which the work is distributed among the several observers is admirably adapted to meet the ends aimed at by the Committee. The areas are divided into subzones of 1 deg. of latitude, and they are allotted to observers in such a way that, by each pair overlapping and dovetailing into the adjoining pairs, every object shall be brought under the eyes of two independent students. It is proposed that the returns which the Committee may receive shall be examined by Mr. Birt, with the aid of a telescope of superior power, after which the state of the objects so examined is to be regarded as authoritatively fixed for the epoch of examination. The most difficult part of the study of the Moon's surface is that of delineation. No two drawings of the same object will ever agree in all the details, and a series of drawings of the same object will manifest very considerable departures from one made at the period of mean libration, which occurs once only in three years. In arranging the formulæ for the computation of the librations of the centre of the apparent disc, Professor Challis, of Cambridge, has rendered this Committee essential service. In preparing Appendix II. in the last volume of reports, which includes libration, Mr. Birt has given (from the *Berliner Astronomisches Jahrbuch für 1843*), the derivation, as arranged by Professor Challis, of the Formulæ for Libration, inserted on p. x. of the Nautical Almanac, and also the formulæ employed by Lohrmann in the computation of points of the first order, including those for libration. The difficulties attendant upon the delineation of the surface being so great, the Committee has not ventured beyond the simple outline of the two areas already issued.

The Crater Linné.—The observations upon this singular crater which have been made from December 12, 1866, up to June 11, 1867, have now been published, and show how advanced is our knowledge of selenography. As Mr. Birt stated at the British Association, three features in

Linné are especially to be noticed:—1. A large ill-defined white spot; 2. A shallow saucer-like depression, very rarely seen; and 3. A small crater, first seen December, as a white hill or black spot—the white hill being the edge of the crater just catching the sun's rays, and the black spot the shadow. In the Circular No. III. of the Lunar Committee, there is an account of the observations of this small crater, or fine black point, as seen by Schmidt, Buckingham, Secchi, Respighi, and Wolf. The largest estimation (Secchi's) of the diameter of this crater previous to April 1867 (*viz.*, Feb. 11, 1867), is 0.33", or 2.352 English feet. It appears from Respighi's communication (*Bulletin Météorologique de l'Observatoire du Collège Romain*, 31st May, 1867), that he observed in April and May, with the equatorial of the Capitoline Observatory, Rome, by Merz, of 4.5 inches (French) aperture, all the main features that have been recorded by Schmidt and others since Oct. 16, 1866—*viz.*, the whitish cloudlike spot of nearly the same extent as the crater Sulpicius Gallus; the ring of a large crater of small depth, probably the ring seen by Messrs. Knott and Webb; the bright point west of the centre of the large white spot, which he found (as the English observers) to be the western border of the small crater; and the small crater itself, to which he gives a diameter of 4.0", or 28,224 English feet. Wolf estimates the diameter at a little less than 1.0", or 7,056 English feet. Whatever may be the truth in the midst of the conflicting *opinions* which have been expressed on the state of Linné (there are no discrepancies in the evidence), it is certain that no lunar spot has received so much attention from *so many observers* as Linné, and that its features are so well determined (with the exception of the diameter of the small crater, 0.33" in February, 4.0" in April and May, 1.0" in June, which, by the way, are *not* contradictory), for the early half of the year 1867, as to furnish reliable evidence of its condition at this epoch. It must be mentioned that Mr. Rutherford, whose observations have been carried on at the other side of the Atlantic, and whose photographs are said to be larger than ours, states that he has been unable to detect any change in the brightness of the locality in question.

The Spectrum of Meteors.—It was stated by Professor Herschel at Dundee, that though the spectroscope showed a yellow light in the case of meteors, it was impossible to say what was the composition of this light. As observers multiplied, however, with telescopes armed with spectroscopes, this difficulty would no doubt be resolved. The connection between comets and meteors had this year been established without doubt, and that connection gave wide scope for speculation as to the origin and character of meteoric bodies. Mr. Huggins had made an observation of the light of a comet, and although that observation was not perfect, still it was sufficient to identify the light of the nucleus of the comet with that of the meteoric bodies. There were two theories as to these meteors. Leverrier had shown that their orbit extended from that of Uranus to that of the Earth, while an Italian astronomer believed that they came from the utmost fields of space. Fifty-six showers were well established; and it was by the study of these showers that they hoped to continue, and possibly confirm and extend, their researches by the assistance of those zealous observers who had hitherto been their supporters and constant assistants among the members and other observers of this Association.

A new Planet, which has been named Undina, has been simultaneously discovered by Peters, of Hamilton College, U. S., and Tietjens, of Berlin. Its magnitude is between the 10th and 11th, and it was first seen on the 7th of July last. This is, then, the 100th or, according to those who believe in the existence of a planet within Mercury's orbit, the 101st planet.

Jupiter without his Satellites.—In our last number Mr. Proctor gave our readers ample notice of this singular phenomenon, and we are glad to find that many of them availed themselves of the opportunity noted. The editor of the *Astronomical Register* says that when the five black spots were projected in the line of the belts, they gave one the idea of "a bar of printed music."

The Meteorlike Bodies near the Sun, which were described by Mr. Lowe and Mr. Bird, are alleged by Mr. C. L. Prince to have been nothing more than seeds of dandelion, floating through the atmosphere. The direction of these pseudo-meteors will be always found to coincide with that of the wind.

Change of Focus in observing Stars.—The change of focus which is said to be requisite in the examination of stars widely separated in altitude, has been inquired into by Captain Noble, who lately laid a paper on the subject before the Royal Astronomical Society. We conclude, from his observations, that in the finest state of the atmosphere the foci of all stars are identical. But he says that when, as in the normal state of things, there is an appreciable amount of vapour near the horizon, a shortening of the focus of a telescope, directed to objects in its neighbourhood, may take place.—Vide *Monthly Notices*, June 14.

The Expansion of Brass Pendula.—Major Tennant publishes a singular paper on this point. It would seem, from the evidence adduced by the author, that at a pressure of only five inches of mercury the coefficient of expansion of the brass pendulum must not only be increased, but appears to be 13 per cent. greater than ever before has been assigned to brass.

Comets and Meteors.—In a paper on this subject, laid before the last meeting of the Astronomical Society, Mr. G. J. Stoney, Secretary to the Queen's University in Ireland, make the following interesting observations, which tend to show, as Schiaparelli has already pointed out, that there is a very natural relationship between comets and meteors. If interstellar space, external to the Solar System, be, as is most probable, peopled with innumerable meteoric bodies independent of one another, a comet while outside the Solar System would in the lapse of ages collect a vast cluster of such meteorites within itself. Each meteorite which approached the comet would in general do so in a parabolic orbit; and, if it came near enough to pass through a part of the comet, this parabolic orbit would, by the resistance of the matter of the comet, be converted into an ellipse. The meteor would therefore return again and again, and on each occasion that it passed through the comet its orbit would be still further shortened, until at length it would fall in, and add one to whatever cluster had been brought together by the previous repetitions of this process. In this way a comet, while moving in outer space, beyond the reach of the many powerful disturbing influences which prevail within the Solar System, would inevitably accumulate within itself just such a globular cluster of meteorites as the November meteors must have been before they became associated with the Solar System.

The Nebula of Orion.—Father Secchi has presented to the French Academy a drawing of the nebula of Orion, which was lately prepared at the Roman College, and which he proposes to publish on his return to Rome. Spectrum-analysis of the nebula proves it, like its fellows, to be composed essentially of some gaseous compound.

The Pascal-Newton controversy still continues. Mr. Chasle still contends that the documents in his possession are genuine. On the other hand, Sir D. Brewster and Mr. Faugère hold that they are forgeries. The arguments of Sir David seem invincible, but Mr. Chasle's most recent communications to the Academy show that he is undaunted. The question whether Newton or Pascal discovered the law of gravitation cannot, therefore, be regarded as definitely decided.

BOTANY.

The Moving Corpuscles of Valisneria.—In a paper read before the Philosophical Society of Manchester on the 18th of July, Mr. J. G. Lynde describes some recent observations made by him with a view to discover the cause of the motion of the corpuscles. The result arrived at seems to be that cilia are most probably present. Mr. Lynde does not positively assert that this is the case, but he contends that it is most probable. After various fruitless experiments, he determined to try the effect of polarised light. Having produced a dark-blue ground by one of Daker's selenites, he put on a $\frac{1}{8}$ -inch object, and examined a portion of the leaf, in which the circulation was rather sluggish. All over the surface of the cells he perceived "brilliant gold-coloured scintillations which had all the appearance of cilia in motion, and repeated observations showed precisely the same phenomena." Notwithstanding all that he has seen, he cannot say that he is convinced the appearances can be attributed to nothing else but cilia; it is possible they may be due to the presence of active corpuscles—as suggested by Mr. Wenham in his paper on the Leaf-cells of *Anacharis Aleinastrum*, published in the *Microscopical Journal* for 1855—which corpuscles may be Vibrions, described by Dr. Cohn in his "Researches on the Development of the Microscopic Algæ and Fungi," as representing the developmental condition of a plant, but it is only by further research that this point can be definitely settled. The result of his observations so far appears to be that in addition to the wave of light already seen, the separate objects causing that wave may now be observed in the manner described. What these objects are is still a matter to be determined, but at present Mr. Lynde is inclined to believe them to be cilia on the cell-wall, while at the same time there are also independent moving corpuscles within the cell; some of these bodies have the appearance of crystals, and in one specimen a great number of starch-granules in the cells were observed.

A Cure for Dry-rot.—The terrible destruction of timber caused by the spread of the fungus known as *Merulius lachrymans* leads us to record any suggested mode of preventing the propagation of the fungus. The mode most recently recommended is that which Mr. Lunge refers to in a letter in the *Chemical News*. Mr. Lunge thinks that the dry-rot is generally introduced into houses with the clay which is so often employed for filling the

spaces between the joists and branding of a chamber-floor. He thinks, therefore, that by filling this space with a material which destroys the fungus, the prevention of dry-rot may be effected. The substance which he considers especially effective for the purpose is the tank-waste from alkali-works. This, he says, "may be had at all alkali-works for carting away."

Hawaiian Plants.—A critical list of the plants of the Hawaiian Islands is being brought out in the Proceedings of the American Academy by Mr. Horace Mann. This is not, however, the first. Indeed, it must only be regarded as a supplement to the fine work which was executed by Dr. Berthold Seemann, the editor of the *Journal of Botany*.

No new Genera of Plants in the year 1900!—In a curious statistical paper read by M. de Candolle at the International Botanical Congress, the author expressed his belief that by the end of this century botanists will have become acquainted with every genus of plants on the face of the globe, and will thenceforth occupy themselves with only species and varieties. The facts on which M. de Candolle bases this opinion is, that the number of new genera has diminished in a certain arithmetical order, while the number of plant-seekers has proportionally increased.

The Fall of the Leaf.—M. Trécul has recently presented to the French Academy a most valuable series of memoirs on the structure of the "proper vessels" of the order *Terebinthaceæ*. In concluding one of his recent memoirs, he calls attention to a phenomenon which occurs just before the fall of the leaf, and which is not unlike the process which accompanies the shedding of horns in animals. It consists in the obstruction of the "proper" vessels at the base of the petiole (foot-stalk). This obstruction is effected by the multiplication of cells, which first shows itself in the parietes of the vessels. The cells increase and multiply until at last the vessels are completely choked up in the neighbourhood of the insertion of the leaf, although in other portions the vessels retain their normal characters.

The Contractions of the Sensitive Plant.—These have formed the subject of two essays published in the *Comptes Rendus* for July and August, and written respectively by M. P. L. Bert and M. de Blondeau. The chief conclusion at which Mr. Bert arrives is, that the natural and regular movement of the leaves is produced by a different cause from that of sudden contraction resulting from contact with the fingers. Either seems to have no effect upon the former, but it produces an anæsthetic effect which prevents the latter. M. Blondeau's enquiries are more important. M. Blondeau experimented on the plants with the induced galvanic current of a Ruhmkorff's coil. He submitted three plants to the influence of the electric current. The first was operated on for five minutes; the plant when left to itself seemed prostrated, but after a while (a quarter of an hour), the leaves opened, and it seemed to recover itself. The second was acted on for ten minutes. This specimen was prostrate for an hour, after which it slowly recovered. The third specimen was galvanised for twenty-five minutes, but it never recovered, and in twenty-four hours it had the appearance of a plant struck by lightning. A fourth plant was etherised, and then exposed to the current. Strange to say, the latter had not any effect, the leaves remained straight and open; thus proving, says M. Blondeau, that

the mode of contraction of the leaves of the sensitive plant is in some way allied to the muscular contraction of animals.

The International Botanical Congress was held at Paris on the 16th. The meeting was held in the rooms of the Imperial Society of Horticulture, and was presided over by M. Alphonse de Candolle. Almost every European country was represented.

The Fossil Plants of Bilin.—Herr Ettingshausen has published the third part of his fossil flora of the Tertiary basin of Bilin, in Bohemia. He treats of about thirty-four orders of plants belonging to the locality, and alleges that in great part the genera are the same as those which are now found living in the neighbourhood.

A new Conifer from Arctic America is described by Mr. Andrew Murray, in the *Journal of Botany* for September. The plant, which was referred to *Abies alba* by Dr. B. Seemann, was first found by him and Lieutenant Bedford Pim, and specimens of its wood may be seen in the Museum at Kew. It is the most northerly tree met with in the north-west coast of America, being found in a latitude nearly seven degrees farther north than the limit of trees on the eastern side of the American continent. Some of the trees measured from twenty to fifty feet in height, and from four to five feet in circumference.

Adiantum Capillus-Junonis.—This rare species of maidenhair fern has been hitherto imperfectly described. We are glad, therefore, to receive a more accurate and complete description of it from Dr. H. F. Hance, who has lately found some fine specimens growing in the interstices of the bricks in the walls of the city of Canton. It seems to resemble rather closely *A. lunulatum*, but is nevertheless quite distinct from it. The species was originally described by Dr. Hana (in *Annales des Sciences Naturelles*) as the *A. Cantonense*; but the fact that an identical species found at Peking had been styled by Dr. W. S. Williams *A. Capillus-Junonis*, induced the author to employ this latter specific name instead of *Cantonense*.

An edible Fungus from Tahiti is described by Mr. Brander as being an article of commerce in the South Pacific Islands. It grows upon decayed trees, and is called *Teria iore*, or rat's ear, by the natives. This fungus was first collected in 1863, and is said to fetch twenty cents per pound in China, where it is used in preparing certain soups.

A Memorial of Sir W. Hooker is about to be erected in Kew Church. It consists of a tablet enclosing a cast in Wedgwood-ware of Mr. Woolner's medallion of the late Sir William Hooker. The medallion occupies the centre of a composition of panels that are decorated with ferns, etc., in relief, the fronds being arranged so that their lines harmonise with their position on the monument; the panels are divided and mounted in mouldings of white marble. The tablet is the work of Mr. R. Palgrave, and is considered exquisite in design and execution.

The presence of Gases in Plant-tissues.—At a recent meeting of the Botanical Society of Edinburgh, a most interesting paper was presented by Messrs. Faivre and Dupré. The plants especially examined by the authors were the mulberry and the vine, and the following are the conclusions arrived at:—1. The presence of gases in the interior of the root, of the stem, and of the branches in the mulberry and vine, is a normal and constant fact.—2. The

composition of these gases changes with the epochs of vegetation.—3. During the period of inactivity, carbonic acid is in very small proportion, and is scarcely appreciable. Oxygen is present to the same extent as in atmospheric air. During the phase of activity the contrary takes place, and the changes are more marked in proportion as the vegetation is more energetic; with the progress of vegetation, the proportion of oxygen diminishes.—4. In the roots, during the epoch of vegetation, the quantity of oxygen is not so great, while that of carbonic acid is greater than in the branches examined under the same circumstances.—5. In the branches, as in the roots, there is an inverse relation between the oxygen and the carbonic acid; by adding to the normal oxygen that disengaged under the form of carbonic acid, we obtain a number which is scarcely above the proportion of oxygen in the air.—6. In the mulberry and the vine, injections do not penetrate the pith or the bark, whether in the branches or roots. The ligneous layers are alone permeable to mercury. The more the formation of vessels increases, the easier and more complete are the injections. The injections are fuller in the roots than the branches; they are also more in the branches than in the young herbaceous shoots. In the old stems of the mulberry, the central layers cease to be permeable.—7. Microscopic examination proves that the injection specially penetrates the pitted and reticulated vessels, and also the spiral vessels in the young herbaceous shoots.—8. The pitted vessels show distinctly the mercury in the areolæ, as if in so many little pouches formed by thin portions of the wall; the same observations have been made in regard to the reticulated vessels.

Aphylllostachys.—Professor H. R. Goeppert's fine memoir on this singular fossil plant, has been translated in the *Journal of Botany* for August. The author makes it the text of a sermon on Darwinism. In the course of his remarks he urges that no arguments in favour of the theory of Natural Selection are to be found in the order in which plants present themselves as regards their geological succession; for it is known that the highest and lowest alge existed at the same period. Herr Goeppert's arguments are not, however, quite conclusive: how, indeed, could they be so in the brief space he allots for the discussion of a question which hangs on so large a mass of botanical evidence? His observations on the character of *Aphylllostachys* are much more important than his theoretical abstractions. He describes the specimen very minutely, and the plate which accompanies the paper gives one a clear notion of the character of the plant; still he feels unable to decide on its affinities. He cannot find an analogous form in either recent or extinct floræ, and he now, after fifteen years, is compelled to lay the matter before other botanists, in order that they may settle it.

Botany at the British Museum.—The Annual Report shows that the officials in the Botanical Department have certainly not been idle during the past twelve months. The addition of specimens to the Museum amounts to several thousands; and of microscopic slides of *Diatomaceæ* no less than 5,000 have been purchased. In fact, the whole of the valuable collection of the late Dr. Greville and the late Dr. Gregory are now to be seen in the British Museum.

A new South African *Senecio* has been discovered by Mr. M'Owan, of
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Grahamstown, and has been identified by Dr. F. Mueller, of Melbourne. The species is styled *S. tropæolifolius*. Dr. Mueller, in commenting on this discovery, makes the following very interesting remarks on the geographical distribution of the genus:—*Senecio* is not merely more widely distributed over the globe than any other existing genus, from the polar to the equinoctial regions of both hemispheres (though almost absent in North Australia), but it embraces more species than any other—nearly a thousand being on record, some, however, but ill-defined. The genus almost as rich in species, and almost as extensively diffused, is *Solanum*, and then seemingly follow *Panicum*, *Carex*, and *Euphorbia*, though in Australia *Acacia* largely surpasses all others. The species of *Senecio*, as representatives from almost every part of the globe, become thus of the greatest possible interest, and are certain to be always among the first which come under the notice of any photographic observer. The Groundsels, though generally of the more humble forms of vegetation, present, in a recently discovered species from the Chatham Islands (*Senecio Huntii*: "Vegetation of the Chatham Islands, sketched by F. M., p. 23, plate 3); and in the Victorian and Tasmanian *S. Bedfordii* (F. M., Report, 1858, p. 26), fair-sized trees, perhaps the only truly arborescent species of the globe.

The Arctic Cladonia.—On this group of plants an essay, which we hope to see printed in full, was read before the Botanical Society of Edinburgh, by Dr. W. Lauder Lindsay. The Arctic regions include vast level, generally treeless, barren tracts of country, whose vegetation is frequently exclusively lichenose; sometimes, indeed, consisting of a single species, the cosmopolite *Cladonia rangiferina*. The author enumerates the different species and their forms, belonging to the *Cladonia*, found in Arctic countries, and remarked that, whether these may be regarded as consisting of many or few species, their importance to man cannot be estimated by their mere numerical relations; one species at least (*C. rangiferina*) is not only superior in economical and even political importance to the better-known "Orchella-weed," but it is even on a footing with the valuable grains, timber trees, and other phanerogams of more favoured regions. The author considered the economical value and applications of the Arctic *Cladonia* under the following heads:—1, as fodder or forage to animals, domesticated or wild; 2, as an ingredient of man's food; 3, as medicines, being used as tonics, astringents, febrifuges, emetics; 4, in the arts—*e. g.*, perfumery and dyeing.

The Parasites of a Desmid.—Mr. W. Archer, who is one of our most industrious students of microscopic Algae, records that he has found Asteridia parasitic in the common Desmid, *Penium digitus*. In a collection containing a number of the *Penium digitus*, Mr. Archer observed that a considerable number of them showed "some individuals one, the majority two, and a few three, quite identical stellate bodies in the interior of each cell." These seemed to him evidently to have been formed at the expense of the individual *Penium* in which they occurred. These stellate bodies Mr. Archer identifies as the Asteridia. He lays down the following general propositions in concluding his paper:—(1) The strictly parasitic nature of the Asteridia seems probable, from the destruction of the *Penium* during their formation; (2) The observation is of interest as being the first record of the occurrence of "Asteridia" in Desmids; and (3) from their being of a form and size not before noted in any of the Asteridia recorded.

The Movement of the Oscillariae, according to the researches of Dr. Ferdinand Cohn, depend on three facts:—1st, a steady but changeable rotation around the long axis of the plant; 2nd, the power of being able to push itself variably backwards and forwards; 3rd, the power of being able to bend, to stretch, and to twist—in one word, its flexibility.—Vide *Quarterly Journal of Microscopical Science*, July.

CHEMISTRY.

New Method of Organic Analysis.—Herr A. Mitscherlich describes a new mode of organic analysis, which he states is applicable to all organic, and many inorganic, compounds, and one of whose especial features is the direct determination of the oxygen. Those who wish to pursue the method must consult the original paper, the following being only a general account of the process:—Oxygen and hydrogen are determined together by heating the substance in a current of chlorine, passing the products of combustion over red-hot charcoal, and absorbing the chlorhydric acid, carbonic anhydride, and carbonic oxide formed by a saturated solution of plumbic nitrate, a solution of potassic hydrate, and a solution of cuprous chloride in chlorhydric acid respectively. Chlorine, bromine, iodine, and sulphur, are determined simultaneously with carbon and nitrogen, by volatilising the substance in a current of hydrogen, burning the mixed gases and vapours with oxygen, removing the water by means of sulphuric acid, and collecting the products of combustion in weighed vessels—with the exception of nitrogen, which is measured. The products of combustion, besides the water, may consist of carbonic anhydride, chlorhydric acid, bromine, iodine, sulphurous acid, sulphuric acid, and traces of brom- and chlorhydric acid. A residue of carbon also may be left in the combustion-tube. The water is absorbed by sulphuric acid, the chlorhydric acid by plumbic nitrate, bromine by mercuric oxide, iodine is weighed as such, sulphurous acid is absorbed by potassic bichromate, carbonic anhydride by potassic hydrate, nitrogen is measured, and the residual carbon weighed.—Vide *Poggendorff's Annalen*, cxxx. 536.

A Syphon for the Laboratory.—It so often happens that in using the ordinary syphon, acid and hurtful substances are introduced into the mouth, that a new syphon, invented by M. Zaliwski Mikoraki, will be gladly employed by chemists. The new syphon is not set at work by suction. One of its legs is provided with an accessory tube, by blowing through which the current becomes established.

Chemical Relations of Caffeic Acid.—At a late meeting of the Academy of Sciences of Vienna, Herr Hlasivetz read a paper on this subject. He found that by treating the acid with sodium-amalgam he produced a *hydracid* by the addition of two atoms of hydrogen. This shows that there is an analogy between caffeic acid and cinnamonic and coumaric acids. The three thus belong to one series, each term of which possesses an atom of oxygen more than the preceding one. Caffeic acid is isomeric with *umbellic*, *everminic*, and *veratic* acids.

Cheap Mode of obtaining Oxygen.—M. de Motay has suggested an economical method of producing oxygen, which is said to prove easy and efficient

in practice. The substance used is manganate of soda, which M. de Motay hopes to be able to sell to the trade at fourpence per kilogramme. Fifty kilogrammes of manganate give, according to calculation, from 400 to 450 litres of oxygen per hour.

An Illustration of the Manufacture of Sulphuric Acid, which is very simple, and may be found useful by lecturers as an experiment, has been described by a correspondent of the *Chemical News*. It is a modification of an experiment described by Dr. Miller. Three tubes are passed through the cork of a wide-mouthed bottle, the largest being connected by an india-rubber junction with a pint funnel, and the small one to the left with a test-tube generating NO by means of copper turnings and nitric acid. The middle tube admits air. A little water is poured into the bottle first, to combine with SO_2 for the production of H_2SO_4 . The funnel is covered in with a metal cap, to which a small pan is suspended. This pan is a miniature furnace. A bit of sulphur is placed in it and lighted. The fumes of SO_2 immediately flow down in a conspicuous stream into the bottle. Here they encounter NO, and the usual reaction takes place. Any SO_2 which the water may dissolve is expelled by boiling, when the solution answers to all the tests for the presence of sulphuric acid. An extra cover, which slides on the metal lid, conceals some air-holes, useful at the beginning of the experiment.

The Estimation of Organic Matter in Water.—This is a subject of the utmost importance, and it is much to be regretted that it has not received the attention it deserves. At least we judge so from the fact that till recently we have had no reliable method of distinguishing between the organic matter present in water or ammonia and that present as excrementitious substance. It has lately been shown by Messrs. Wanklyn and Chapman that the methods pursued by Drs. Frankland and Letheby hardly compass this end. These chemists have therefore suggested the employment of a new method of estimating organic matter. This method has been fully described in their joint paper, read before the Chemical Society on the 20th of June last; but the following account gives an idea of the nature of their method:—Direct experiments were made upon known quantities of urea, albumen, and gelatin dissolved in water, and the singular fact was disclosed that, whilst the first of these bodies is completely changed into ammonia by boiling with *carbonate of soda*, the two latter substances resist decomposition until *caustic soda* (or potash) is introduced, when *one-third* of the nitrogen contained in them is evolved in the form of ammonia. The remaining *two-thirds* of this constituent are finally liberated in the same form upon adding some crystals of the permanganate of potash and continuing the distillation. The authors employ Nessler's test for indicating the proportion of ammonia originally contained as such in the water, as well as that subsequently formed.

The Density of Ozone.—M. Soret, who sometime since stated the density of ozone to be $1\frac{1}{2}$ times that of oxygen, now has given convincing proof of the accuracy of his opinion. By causing the two bodies to "diffuse," he has found that the velocities of transmission give the same value for the density of ozone as that already expressed, viz. $1\frac{1}{2}$ times that of oxygen.

Detection of Bromine and Iodine in same Solution.—A paper has been pub-

lished in the *Comptes Rendus* from the pen of Dr. T. L. Phipson, in which the author points out what he considers to be a simple mode of ascertaining the presence of bromine and iodine in the same solution. The method is based on the fact that in the presence of sulphide of carbon and free chlorine, iodides are first decomposed and afterwards the bromides, and further, that the chlorine acts upon the iodine dissolved in the sulphide of carbon to form quinti-chloride of iodine, which dissolves, and leaves the sulphide of carbon colourless. If bromides be present, the sulphide of carbon assumes an orange colour.

Chlorine and Manganese have been combined by M. Niclés in such proportions as to form a deuto-chloride, which is, however, a less permanent salt than the other haloid combination of this base.

The Impurities of the New (?) Anæsthetic.—In a paper read before the British Medical Association at its meeting in August, Dr. Protheroe Smith read a paper on Tetrachloride of Carbon, in which he gave the following directions for the detection of its three impurities. These are as follow:—

1. *Bisulphide of Carbon.*—This is easily detected by evaporating over a spirit-lamp a portion of the suspected fluid in a deep cup, when, if it contains bisulphide, a slightly bluish flame will appear, whereas if free from this impurity it would be entirely uninflamable. 2. *Free Sulphur.*—Should such exist, after spontaneous evaporation of some of the tetrachloride on a watch-glass, a fine opaque film will remain, which when heated would give off the well-known fumes of sulphurous acid. 3. A peculiar sulphur-compound, which is discovered by dipping in the suspected fluid some clean blotting-paper, which when dry will give a peculiar unpleasant smell of dirty linen.

A New Cement—Oxychloride of Magnesium.—At a late meeting of the French Academy, M. Dumas called attention to a new manufacture of M. Sorel's, a cement produced by combining chloride of magnesium with oxide of magnesium, and possessing, as does the oxychloride of zinc, in a degree incomparably greater than plaster of Paris, the property of not only taking all variety of forms, but of solidifying and taking a high polish. Experiments made two years ago leave no doubt as to the good quality of stones prepared by this process, and the absolute resistance, of objects so fabricated and moulded, to the deleterious action of water. "Industry and art will therefore enter into possession of new elements of construction and transformation. The chloride of magnesium that can be extracted from seawater, or which is found in great quantities solidified in interior seas as that of Stassfurth, does not require to be entirely pure, and costs less than the oxychloride of zinc."

Estimation of Lime in Analysis.—At a meeting of the French Academy, M. Boussingault communicated a new mode of finding the quantities of lime in analysis. The process consists in precipitating the lime in the state of sulphate, which is decomposed either by a Bunsen gas blowpipe, or by one of Schlösing's furnaces, the sulphuric acid being vaporised, and the lime remaining pure. In several experiments on the decomposition of earthy or metallic sulphates, M. Boussingault remarked frequent anomalies, the quantity of the base remaining often being less than it ought to be. The fact is not easy to account for.

Manager of the French Mint.—The post of Director of the Paris Mint, vacant by the death of M. Pelouze, has been given to M. Dumas, the eminent chemist. M. Dumas had previously resigned his appointment of professor in the faculty of science of the University of Paris, and inspector-general of the high schools of France.

Cause of the Decolorisation of Iodine Starch.—In a paper, published in the *Bulletins de la Société Chimique*, M. Pellét states the following conclusions as the results of his experiments in the cause of the decolorisation of the iodine starch, and the reappearance of colour on cooling:—1. Decolorisation is caused by the solution of iodine starch in an excess of hot starch; the solubility being less in the cold, the colour reappears again on cooling.—2. Iodine starch is decomposed at 100°C, and iodine volatilises.—3. Iodine starch remains unchanged in alcohol, being equally insoluble in that liquor whether hot or cold.—4. Iodine starch may be regarded as a salt, which in certain solvents is more readily soluble when hot, than when they are cold.

Silicates of Methyl.—In a recent number of Silliman's *American Journal*, there appears the following account of the mode of preparing the above compound. It was first attempted, by Messrs. Friedel and Crafts, to prepare the silicate by reacting on methylic alcohol with chloride of silicium; like Ebelmen, they obtained a product impossible to purify, turning brown in the air, and possessing a fetid odour. They noticed that this product always contained chlorine. Wood-spirit was purified by treatment with chloride of calcium; the chloride of calcium compound decomposed with water, and the alcohol rectified several times with sodium. The alcohol thus prepared was sealed in a tube with silicate of ethyl, and the mixture heated during 20 hours at 210°C. After several fractional distillations, the principal product isolated from the contents of the tube was a liquid boiling at 143° to 147°. This liquid gave on analysis numbers which correspond with the composition of a mixed silicate, diethylic, dimethylic, silicic ether. There being reason to believe that a minute trace of water contained in the methylic alcohol interfered with the success of the processes in which it was employed, this alcohol was distilled twice with sodium, then with a small quantity of anhydrous phosphoric acid. Thus prepared, it boils at 65·5°, has not the disagreeable odour it usually has, smells like common alcohol, and does not turn brown with soda. Methylic alcohol purified in this way, when added to chloride of silicium, reacts like ordinary alcohol. When the theoretical quantity of the alcohol has been added, the product is distilled, and after a small number of fractional distillations two principal products are obtained, one boiling at 120° to 122°, and the other at 201° to 202·5°. The first is the normal silicate of methyl; the second is the hexamethylic disilicic ether. The normal silicate of methyl is a colourless liquid, has rather an agreeable odour, is soluble in a considerable quantity of water. Moisture or aqueous alcohol gives rise to condensed products, ultimately silica. It burns with a white smoke composed of silica.

Crookesite, a New Thallium Mineral.—A mineral, rich in thallium, has been discovered by M. Nordenskiöld, in Mosander's collection, and has been named Crookesite, in compliment to Mr. W. Crookes, F.R.S., the discoverer of thallium, and the accomplished editor of our contemporary the *Chemical News*. Crookesite forms small, coherent, opaque masses of metallic lustre,

has a lead-grey colour, and sufficiently compact to admit of its ready separation from the grains of eukairite and the powder of berzelianite. I have observed no trace of crystallisation in the mineral. In tenacity and hardness it resembles chalkosine. Its specific gravity = 6.9. Before the blowpipe crookesite fuses easily, forming a lustrous green-black enamel; the flame is coloured intensely green. It is insoluble in hydrochloric acid, but nitric acid dissolves it readily and completely.

Analysis showed it to contain

Copper	.	.	.	.	.	.	45.76
Thallium	.	.	.	.	.	.	17.25
Silver	.	.	.	.	.	.	3.71
Selenium	.	.	.	.	.	.	33.28
							100.00

Street Dust a Poison.—The chemical analysis of W. Tichborne, of Dublin, would serve to show that street dust, which we all take less or more into our nostrils, may be the means of propagating various epidemic diseases. At all events, the following results of analysis show that street-dust contains a very large proportion of organic matter:—

Moist Dust from Grafton Street, Dublin, October 1866.

Moisture	.	.	.	.	.	33.3
Organic matter	.	.	.	.	.	25.1
Inorganic matter.	.	.	.	.	.	41.6
						100.0

Street Dust, October 1866.

Soluble salts	.	.	.	.	.	1.3 per cent.
Organic matter	.	.	.	.	.	25.1 „

Soil from a well-made Road upon which Sea-water had been used.

Soluble salts	.	.	.	.	.	7.5 per cent.
Organic matter	.	.	.	.	.	21.1 „

Here it will be seen that the salts are about $\frac{1}{4}$ the weight of the total organic matters present.—Vide *Chemical News*, July.

The Calculus of Chemical Operations.—The important and philosophic views which Sir Benjamin Brodie recently expressed on this subject have been considered by Dr. A. Crum Brown. In a paper by the latter, read before the British Association at Dundee, the author stated that there were two points which might be taken up for examination:—(1) The idea of a fractional relation between chemical substances; and (2) the manner in which Sir B. Brodie had worked this out. He confined his remarks to the second, and stated that his conclusion was that while the two systems are equally consistent, and may both be treated mathematically, Sir Benjamin's was yet, notwithstanding its elegance, simplicity, and consistency, to be rejected, on the grounds that his fundamental hypothesis is wholly arbitrary, while

change in this would involve considerable change in formulæ, and further, that the present formulæ were quite convenient.

Atomic Weights of Cobalt and Nickel.—These have been investigated by Winkler, who has determined them in the following manner:—The metals were prepared in a state of perfect purity; the cobalt, by reduction of repeatedly recrystallised purpureo-cobaltic chloride in a current of hydrogen at a high temperature. The nickel, by adding to a solution of the commercial carbonate in chlorhydric acid sodic hypochlorite, and treating the liquid in this manner again so long as any cobalt could be detected in it; the solution was then purified from traces of copper and arsenic and precipitated with sodic carbonate. The carbonate was converted into chloride, and sublimed in a current of chlorine, and lastly reduced in a current of hydrogen. Weighed quantities of the metals were then immersed in a perfectly neutral, concentrated, cold solution of sodioauric chloride, and the weight of the precipitated gold determined. The mean of five experiments with cobalt gave the number 29.496. The mean of four with nickel, the number 29.527.

Blowpipe Reaction of Manganese and Chlorate of Potash.—In a recent number of the *Chemical News*, it is stated that if chlorate of potash be heated by means of a blowpipe, in a tube closed at one end till oxygen is evolved, and then a trace of manganese added, the potash-salt will assume a purple colour, owing to the production of permanganate of potash. This reaction of manganese is quite as delicate as the one proposed by Berzelius.

How to test the Purity of Quinine.—In these days of pharmaceutical adulteration, a reliable test for the purity of a drug is of the utmost value. The method, therefore, which M. Stoddart recommends for the detection of quinidine when mixed with quinine, may be of interest to our readers. Six grammes of the suspected quinine are dissolved in a test-tube in 5 grammes sulphuric acid, diluted with 3 grammes water; to this are added 7.5 grammes ether, 18 grammes alcohol, and 2 grammes of a solution of sodic hydrate containing about 8 per cent. The mixture is well shaken, and left to itself for 12 hours. If quinidine, cinchonine, or cinchonidine are present, they will be found in a layer below the ether—quinidine as an oily liquid, cinchonidine in crystals. The second method consists of a microscopic examination of the crystalline precipitate produced in a saturated and neutral solution of quininic sulphate by potassic sulphocyanide.—Vide *Journal Pharm.* iv. 50.

Death of Dr. Thomas Richardson.—The death of Dr. Richardson has been so fully announced in the weekly and monthly journals, that we are only following a routine custom in reporting it. Few English chemists were better or more favourably known to science than Dr. Richardson. He was Reader in Chemistry at the University of Durham, as well as a Fellow of the Royal Societies of London and Edinburgh, and member of the Royal Irish Academy. He died somewhat suddenly, at Wigan, of congestion of the brain. Of late years Dr. Richardson was best known to the chemical world by his work in connection with "Richardson and Watts's Chemical Technology." Several papers of his are to be found in the volumes of the *Chemical News* and *Chemical Gazette*.

New Method of Qualitative Analysis.—A method in which neither sulphuretted hydrogen nor ammoniac sulphide is employed, has been suggested in *Poggendorff's Annalen* (cxxx. 324) by Herr E. Zetnow. The following are

the reagents employed, and the substances they help to throw down and separate from an aqueous solution:—1. Chlorhydric acid precipitates lead, mercury, and silver.—2. Sulphuric acid precipitates lead, barium, strontium, and calcium.—3. Baric hydrate sets free ammonia; the filtrate is used for the detection of sodium and potassium.—4. Zinc is added to the filtrate from 2, the hydrogen ignited and tested for antimony and arsenic; antimony, arsenic, tin, mercury, copper, cadmium, and bismuth are precipitated.—5. Baric carbonate precipitates, from the filtrate of 4, iron, chromium, and aluminium.—6. Ammonic carbonate, after removal of the baryta, precipitates, from the filtrate of 5, manganese and calcium; the filtrate is tested for magnesium, cobalt, and nickel.—7. Zinc is tested for in the original solution.

GEOLOGY AND PALÆONTOLOGY.

The Osteology of the Mesotherium forms the subject of a fine series of memoirs presented to the French Academy by M. Serres. In the first communication, he treats of the structure and relation of the several parts composing the vertebral column, and supplies tables in which are recorded the exact measurements of the various bones examined. The *atlas axis*, fifth dorsal, eighth lumbar, and fourth coccygeal vertebræ have been especially dwelt on by the author. M. Serres remarks that, in determining the true osteogenical relations of the parts of the skeleton, it is necessary to study the bones in their foetal state. This is, of course, impossible in the case of fossil skeletons. He suggests, therefore, that the palæontologist should examine the state of solidification and the density of the different parts of the compound bones. This, he says, will give a clue to their developmental relations. This rule applied to the *Mesotherium* shows that in the development of its spinal column, the laminae, as in all mammalia, were the first to ossify; the ossification of the centres took place subsequently.—Vide *Comptes Rendus*, July and August.

The Volcanic Disturbances at Santorin.—A letter published in a late number of *L'Institut* reports that the disturbances of the Santorin group of islands continue. New portions of the sea-bottom have been elevated, and some of them have appeared above water. The raised portions are within four or five metres of Micra-Kammeni. Formerly the channel was twenty-one inches deep, but it is now not more than three. The island of Aphroessa remains stationary, but Vattia is now divided into two islands. Around the newly-formed lands the sea is of a yellowish-green colour, and has a temperature varying, according to the locality, from 25° to 75° centigrade. M. Cigalla, who has studied the volcanic phenomena very carefully, thinks another great eruption will soon occur, and that a true volcanic crater will be formed at the top of the George island.

The Magnetic Needle in the study of Volcanic Districts.—A theory of some novelty, and which appears to have been put to a practical test, has been started by M. Jansenn, who has been exploring the Santorin region. This eminent physicist alleges that the magnetic needle may be employed to detect disturbances which take place at such a depth that they are not recognisable

by the ordinary methods. With regard to his experiments in Santorin, he says that the observations made show that there is a very powerful magnetic influence in the direction of the volcanic lines already mapped out by M. Fouqué, and indicated by the eruptive centres *Micra*, *Georges*, and *Aphroessa*. He found the magnetic needle dip very much less in those parts beyond the volcanic region than in others. M. Fouqué's study of the district in the neighbourhood of Aphroessa led him to suspect the existence of a secondary fissure. M. Jansenn has brought his magnetic tests to bear on this question, and he has found that the magnetic records tend very strongly to bear out M. Fouqué's suspicion. M. Jansenn recommends Government to insist on general magnetic observations during surveys, &c., as he says they afford us a means of sounding the depths of solid strata, and possibly of anticipating earthquakes.

Fossil Foraminifera of Austria.—At one of the late sittings of the Imperial Academy of Vienna, Herr Reus presented his treatise on the Foraminiferous Faunæ of the country. He recorded several new species, most of which are referred to the family Miliolidæ.

Spectroscopic Examination of the Flames of Stromboli.—This curious investigation has been conducted by M. Jansenn, who has made known his results in a letter to M. Saint-Claire Deville. There was considerable difficulty in conducting the observations, owing to the quantity of fine powdery matter thrown up with the flame. But M. Jansenn was able to demonstrate the presence of sodium in large quantity, and of copper, chlorine, and carbon in lesser proportions. The flame, as usually occurs in such cases, resulted from hydrogen.

The Amazon Valley.—Professor Agassiz has written a letter to M. Elie de Beaumont, describing the geological character of the Amazon Valley. He states that the valley consists of a species of mud, of which portions are extremely hard; it extends from Para to Peru, and appears to rest on a cretaceous deposit. The river has cut its bed through the mud, and this latter has, in some instances, a depth of nearly a thousand feet.

The Fossil Plants of Wolfgang have been described by Herr Unger in a communication to the Vienna Academy. The species belong to the lower cretaceous beds.

The Bone-caves of Belgium.—In a late number of the *Bulletin* of the Royal Academy of Brussels, a note appears from M. Dupont, in which this geologist states that he has been examining a new bone-cavern known as the Trou-madame. In the stratified mud he found a series of human bones, remains of pottery, bones of deer, and other animals. The human remains include a perfect skull and lower maxilla.

Photographs of the Sierra Nevada.—A set of photographs of this mountain-chain has been sent to Paris by a geologist of California. They exhibit various marks of striation resembling those of the Alps. These are found to occur at a height of 3,000 metres above the sea-level.

Volcanic Eruptions near Portugal.—M. Deville has called attention to a statement which recently appeared in a Portuguese journal, announcing that Tersira and Graciosa, two islands near Lisbon, have been subjected to continual volcanic eruptions; very strong shocks of earthquakes have been felt, and have produced many islets, one after the other, analogous

to those of Santorin, in Greece. On the 1st June a submarine volcano cast up igneous matters in such quantity, that a tongue of land has been formed with the continent. This ground is as yet unapproachable, on account of the incandescence of the rocks, as well as the sulphurous vapours from the fissures. M. Deville asked that the Academy should take an interest in these new eruptions, as it did in those of Santorin.—Vide *Comptes Rendus*, July 1.

A Burning Well.—While some artisans were engaged in making borings for an artesian well at Narbonne, the water rushed forth with great violence, and soon burst into flame. The flame, which arises from the combustion of carburetted hydrogen, is reddish and smoky, and does not emit a smell either of bitumen or sulphuretted hydrogen. The "sinking" for the spring was made on the left branch of the Aude, in a plain situate about two metres above the sea-level, and composed of alluvial mud. The alluvial mud extends to a depth of six metres; then follow tertiary limestones and marls, with the remains of marine shells. At the depth of 70 metres, the spring containing the inflammable gas was met with.

The Plant-beds of North Greenland.—From the report made by the Secretary of the Committee on this subject to the British Association at its recent meeting, it would seem that nothing has as yet been published on the points investigated. Mr. Whymper started from Copenhagen on the 20th of April, but no intelligence has since been received from him.

The Leaf-beds of Hampshire.—The report on this subject was presented to the British Association by Mr. W. Stephen Mitchell, who pointed out that there was a better chance of determining the remains from these beds than those from many others. He laid stress on the fact that we know the age of the beds from stratigraphical evidence not depending on botanical testimony.

The Internal Heat of the Earth forms the subject of a memoir by Dr. J. Schwarz, who arrives at the following conclusions:—The different corollaries of the central-fire doctrine were not adequate to explain the different groups of natural phenomena, for the sake of which these corollaries were deemed essential fifty years ago. The whole system of the central-fire doctrine, the alleged dubious moment of the increase of underground temperature alone excepted, was bound up merely by artificial ties; and as soon as the question of the supposed increase of underground temperature will be, by direct empirical argument, decided in the negative, then the ruin of the whole central-fire system would be inevitable. The memoir concludes with some suggestions as to how experiments should be made in order to ascertain the temperature of the earth, at different depths, simultaneously in different quarters of the globe.—*British Association: Dundee Meeting.*

Palæozoic Insects of Nova Scotia.—Professor Dawson, of McGill's College, Montreal, has a paper in the *Geological Magazine*, in which he describes some interesting insect-remains from the palæozoic rocks of Nova Scotia. In the Nova-Scotian coalfields insects have not hitherto been discovered, except in some fragments found by the author some time since. Last year, however, a very beautiful wing was found by Mr. J. Barnes, of Halifax, in a bed of shale at Cape Breton. This specimen has been examined by Mr. S. Scudder, of Boston, who pronounces it to be a member

of the Ephemeridæ, and gives it the name of *Haplophlebiæ Barnesii* in compliment to its discoverer. It must have belonged to an insect measuring at least seven inches across the wing. Commenting on the conditions under which it lived, Dr. Dawson says: "When we consider that the larvæ of such creatures inhabit the water, and delight in muddy bottoms rich in vegetable matter, we can easily understand that the swamps and creeks of Carboniferous Acadia, with its probable mild and equable climate, must have been especially favourable to such creatures; and we can imagine the larvæ of these gigantic Ephemeræ swarming on the deep black mud of the ponds in these swamps, and furnishing a great part of the food of the fishes inhabiting them; while the perfect insects, emerging from the waters to enjoy their brief space of aerial life, would flit in millions over the quiet pools and through the dense thickets of the coal-swamps."—Vide *Geological Magazine*, September.

Zone of Ammonites Transversarius.—A paper on this subject, by the late Dr. Oppel, has been communicated to the Imperial Geological Institute of Vienna. This zone of the *Upper Jurassic* series is limited above by the zone of *Terebratula impressa*. It may be traced from South-west Poland, through the Carpathians, Moravia, Bavaria, the Schwäbische Alps, the Swiss Jura, the Alps, France, and Spain, as far as Algeria. The number of fossil species known to occur in it amount to 217; among them are microscopic remains of Crustacea and Radiata, and many new species of Foraminifera.

Hungarian Fossil Mammals.—Herr Hantken records the discovery of the following remains from the Post-pliocene deposits of Fünfkirchen:—*Ursus spelæus*, many fragments of lower jaws, loose teeth, and vertebrae; *Hyæna spelæa*, Goldf., a fragment of a jaw belonging to a young animal, with the first teeth and protruding canines; *Equus fossilis*, Cuv., a fragment of a lower jaw with a tooth; *Bos priscus*, Boj., a second collar vertebra; *Rhinoceros tichorhinus*, Cuv., a single tooth.

The Sulphur Springs of Formosa.—At the last meeting of the Geological Society, Mr. C. Collingwood, M.B., presented a paper on the sulphur-springs of Northern Formosa. These springs are situated amongst the hills near Tamsuy, in the north-eastern corner of the island of Formosa, and indicate the existence of volcanic action near the surface of the region—a phenomenon otherwise afforded by the frequent occurrence there of earthquakes. One spring possessed the character of a mountain-torrent, and had a temperature of about 130°. The spot containing most of the springs occupies about two acres of ground, is quite barren of vegetation, and is covered with low hillocks of friable rocks and débris, interspersed with shallow pits containing mud, sand, and sometimes water. From cracks and fissures in these depressions arose clouds of steam; and around them was strewn a quantity of sublimated sulphur, the yellow colour of which was visible from a distance.

Shells in the Ruins of Pompeii.—Among the objects to be seen at the Museo Borbonico at Naples, is a collection of shells taken from some of the ruined houses of Pompeii. These shells have been carefully examined by Mr. R. Damon, who states that they are all those of recent species. He further remarks that some of them are shells only found in Eastern seas, the Indian Ocean, &c. Hence he thinks it not unlikely that they formed part of a Pompeian Museum, and he asks, "Did the original proprietor form one of a

Natural History Society, of which the distinguished naturalist Pliny, who perished at Pompeii, was a member?"—Vide *Geological Magazine*, July.

A Hyæna Den in Carmarthenshire has been described by Dr. Henry Hicks. The cavern is known as the Crygan Cave, and is near Langharne. The bones found by Dr. Hicks were those of *Hyæna spelæa*, *Rhinoceros tichorhinus*, *Elephas primigenius*, *Equus*, and *Cervus*. It is remarkable that most of the bones are gnawed exactly in the same manner as those from Wookey Hole.

Coalfields in St. Catherines, Brazil.—Mr. Edward Thornton has transmitted to London a communication on this subject. The existence of coal in this district has for many years been an established fact; but no practical exploration had been made until the years 1861–63, when Viscount Barbacena, having purchased a tract of land containing the best seams, ascertained the existence of a series of coal-beds at nine different levels, underlying a sandstone formation, horizontally disposed, and varying in thickness from $1\frac{1}{2}$ to 10 feet. Analyses of specimens of the coal prove it to be of good quality, its profitable working depending solely upon the facilities for transport.—*Geological Society*, June 19.

Cretaceous Flora of Belgium.—Mr. E. Coemans has published an essay on the fossil flora of the first stage of the cretaceous strata of Hainault. The plants consist almost exclusively of *Coniferae* and *Cycadææ*.

Banded and Brecciated Concretions.—Mr. John Ruskin, who has returned to the field of geology, has given us, in the *Geological Magazine*, a most interesting paper on the origin of the above forms of concretionary growth. The illustration which accompanies the paper is also most instructive. Mr. Ruskin thinks that the transformations of solid into fragmentary rocks may be ranged under the following heads:—1. Division into fragments by contraction or expansion, and filling of the intervals with a secreted, injected, or infused paste, the degree of change in the relative position of the fragments depending both on their own rate and degree of division, and on the manner of the introduction of the cement.—2. Division into fragments by violence, with subsequent injection or secretion of cement. The walls of most veins supply notable instances of such action, modified by the influence of pure contraction or expansion.—3. Homogeneous segregation, as in oolite and pisolite.—4. Segregation of distinct substances from a homogeneous paste, as of chert out of calcareous beds. My impression is that many so-called siliceous "breccias" are segregations of knotted silex from a semi-siliceous paste; and many so-called brecciated marbles are segregations of proportioned mixtures of iron, alumina, and lime, from an impure calcareous paste.—5. Segregation, accompanied by crystalline action, passing into granitic and porphyritic formations.—*Geological Magazine*, August.

Relations of the Upper and Lower Silurians.—This difficult problem has been solved by Mr. T. Mc'K. Hughes, who, from a very large practical knowledge, arrives at the conclusion long since (1846) stated by Sedgwick—viz., that "on the evidence both of mineral structure and of fossils, we are compelled to separate the coniston flags from the coniston limestone and calcareous slates, placing the former at the base of the Upper Silurian series of the lake district."

Peculiar Stratum in Arbroath Cemetery.—In the Geological Section of the British Association, Mr. Carruthers called attention to specimens of a

ferruginous layer, common in several districts in Scotland, which he had obtained from the new cemetery at Arbroath. It was a thin compact layer, following the surface of the ground, independent of the nature of the soil, and forming a serious barrier to cultivation. It had never been noticed in systematic works, and, as far as Mr. Carruthers knew, no satisfactory explanation had been given of its origin.

Ancient Glacier in the Pyrenees.—M. Chas. Martens, who was present at the meeting of the British Association, read a paper on the ancient glacier of the Valley of Argelez. This glacier and its affluents descended from the crest of the Pyrenees, whose summits now reach an altitude varying from 6,000 to 9,000 feet. The roots of the glacier were in the cirques of Gavarnie, Troumouse, Pragnères, &c., and the glacier extended into the plain as far as the villages of Peyrouse, Loubajac, Ade, Juloz, and Arcisac-les-Angles. Along the valley, polished and striated rocks, scratched pebbles, glacial mud, moraines, and erratic boulders, are the proofs of its existence. At Argelez the thickness of the glacier was about 2,100 feet, and, at the opening of the valley at the foot of the Pic de Geer, near Lourdes, 1,290 feet. Between Lourdes and the village of Ade, the railway runs across seven moraines; and the railway from Lourdes to Pau is cut, as far as the village of Peyrouse, through glacial deposits. The Lake of Lourdes is a glacial lake, barred by a moraine, and surrounded by numerous erratic boulders proceeding from the high Pyrenean mountains. Some of the boulders are of large dimensions: thus one of them, between the lake and the village of Poueyferré, is thirty feet in length, twenty-three feet in width, and eleven feet in height. This lake of Lourdes, surrounded by hills covered with briars, reminds one in many respects of the small lakes of Scotland.

MECHANICAL SCIENCE.

Water Supply of London.—Mr. Ormsby, C.E., has proposed a plan for obtaining the water-supply of London, perhaps more remarkable for its originality than for its practicability. Starting from the idea that all water which has passed through strata of earth is more or less contaminated, Mr. Ormsby proposes to construct non-absorbent receiving beds, by which the entire rainfall will be collected in the same condition of purity as when it reaches the earth. "The arrangement of the collecting surfaces may be illustrated by a chess-board, where each square would represent a collecting basin, the centre of which would be two feet lower than the sides. The lines between those squares would represent walls 12 inches thick, built about 2 feet high, and filled in behind with earth to such a height as to admit a bed of concrete being laid upon it, so that its upper surface may slope from the edge of the wall to the centre of the basin. Upon this bed of concrete, Bangor or other equally good and durable slates are proposed to be laid, set in cement; and when this is done, the waterworks are completed, so that the entire rainfall will immediately flow off into the central pipe or chamber which communicates with the receiving reservoir." Thus, in place of being driven to the sources of the Severn or Thames, or to the lakes of Westmoreland, for his supply of water, Mr. Ormsby would erect his collecting beds

anywhere in the neighbourhood of London, where the atmosphere is sufficiently pure, and obtain his water direct and uncontaminated from the clouds.

Dynamical Transmission of Power.—Of all the recent mechanical inventions exhibited at Paris, probably none is destined to more important applications, or has required a greater amount of practical skill in its development, than the system for the transmission of motive power to great distances, by means of bands of endless wire rope, exhibited by M. Hiru. The single novelty of principle, if such it can be termed, is the substitution of velocity for weight in the rope; but the devices by which the system is carried out, so as to obviate losses of power on the one hand, and injurious wear on the other, are of the highest merit. For transmitting 120 h.p., M. Hiru adopts a rope only 0·4 inches diameter, passing over pulleys 13 or 14 feet diameter, and making 100 revolutions per minute. With these proportions, intermediate supports are not required for less distances than 160 yards. He estimates the loss of power in transmitting 120 h.p. a distance of 12 miles at only 21 h.p. The system has received considerable development in France, having been applied already in 400 instances. An interesting account of the invention will be found in *Engineering* for June 14.

Rifled Small Arms.—The Government have now experimented upon upwards of 80 breech-loading rifles, sent in for competition with the Snider gun. In the trials for rapidity of fire, the time required to discharge at a target 12 rounds of ammunition varied from 39 seconds (Soper rifle, with Boxer cartridge) to 123 seconds.

Gunpowder Magazines.—In reply to the Commission, appointed by Government after the Erith explosion in 1864, to report on the measures which ought to be taken for the safe storage of gunpowder in magazines, Mr. Mallet has written a most interesting letter on the effects of the explosion of large masses of gunpowder, and on the laws of the propagation of the aerial and earth waves which carry destruction to neighbouring objects. The letter will be found in the *Engineer* of June 14. Mr. Mallet does not think that great destruction is likely to be caused by the elastic wave of shock propagated through the earth, except within a very limited area round the focus. To protect the surrounding country from the effects of the aerial wave, he suggests the construction of a large permanent traverse or bank, in the shadow of which surrounding objects would be secure from the direct action of the aerial wave. In order that this traverse may stand, it must be without the sphere of explosion, within which the effect of the explosion is to form a paraboloidal crater in the earth on whose surface it is exploded. The inner slope should have an inclination fixed by the asymptotes of the curve representing the section of the excavated crater. In fact, the magazine should stand in the centre of a conic frustum, or *étançoir*.

Hot Air Engine.—An interesting and novel form of air-engine, exhibited by Mr. Shaw at Paris, has been experimented upon with the following results:—

Duration of experiment, 7 hours.

Average work (indicated), 22 h.p.

Total fuel used (deducting 20 lbs. remaining unburnt, and 18 lbs. wood for lighting), 222 lbs.

Average quantity of fuel per h.p. per hour, 1·4 lbs.

It will be seen, that, so far as economy of fuel is concerned, this engine attains an efficiency hardly ever reached in a heat-engine, ordinary steam-engines requiring $4\frac{1}{2}$ bs. of coal per h.p. per hour, and the best marine engines $2\frac{1}{2}$ lbs. The common vice of air-engines, of inefficiency in the transmission of heat from the furnace to the air, Mr. Shaw obviates by passing the whole of the products of combustion through the cylinder; and to this, doubtless, is to be attributed much of the efficiency of this engine. It remains to be seen whether the practical difficulties which beset the use of air at a high temperature have been overcome. The engine has been working for two months in the Exhibition, apparently without any irremediable defect. Professor Rankine has contributed to the pages of the *Engineer* a mathematical investigation of the action of engines of this kind.

Solid and Laminated Armour Plates.—We have from time to time noticed those results of the experiments against armour-plates which can more strictly be considered as new scientific facts; we may, therefore, mention that recent experiments have given a distinct measure of the relative resistance of solid armour as used universally in this country, and the laminated armour, or armour of superposed plates, generally adopted in America. In the earlier English experiments with cast-iron Armstrong shot, the laminated armour proved to be most materially weaker than solid armour, but in the recent experiments with chilled iron Palliser shot with ogival formed heads, the difference, although still marked, is not so great. Three 7-inch targets were erected, one consisting of a solid plate, another of two $3\frac{1}{2}$ -inch plates, the third of three $2\frac{1}{2}$ -inch plates. With the 7-inch gun and Palliser shot, a charge of $15\frac{1}{2}$ lbs. was required to penetrate the solid plate; 14 lbs. to penetrate the target of two plates; and 13 lbs. to penetrate the target of three plates. The work done in each case is proportional to the charge.

Strength of Iron and Steel, when subject to Vibration and repeated Changes of Load.—M. Wöhler has made some important experiments on this subject, some of the results of which, with diagrams of the apparatus employed, may be found in *Engineering*, August 23. When bars were placed so as to be strained alternately by tension and compression, as is the case with axles, the iron bars broke ultimately with 8 to 9 tons per square inch, and the steel bars with 12 to 15 tons. When the repeated strains were in one direction only, the iron required 15 to 18 tons, and the steel $22\frac{1}{2}$ to 25 tons tension. These bars were strained transversely. Bars subjected to simple tension gave similar results.

Mont Cenis Railway.—This railway, to which reference has already been made in these notes, is now nearly complete, the first engine and train having successfully made the passage from St. Michel to Susa, crossing the mountain barrier between France and Italy at an elevation of 6,700 feet above the sea.

MEDICAL SCIENCE.

Muscular Contraction studied under the Microscope.—The myograph which M. Marey employed in investigating the nature of muscular contraction is said by M. Rouget to give very unsatisfactory results. The opinion which

M. Rouget expresses is that muscular contraction does not consist of a series of successive shocks or vibrations. On the contrary, he says, the muscles of living animals in a state of sustained contraction, appear perfectly motionless when examined by the microscope. The undulations traced by the myograph exist, according to M. Rouget, only during the period of variable contraction, when the exciting influence has not displayed sufficient intensity to call the muscle into complete contraction. When, for example, a powerful electric current is substituted for a weak one, the vibrations, before evident, entirely disappear, the muscle remaining in a perfectly rigid state.

The Relation of Cow-pox to Small-pox.—The report which M. Danet presented to the French Academy of Medicine contains the following conclusions:—1. Cow-pox and small-pox are two distinct maladies. 2. Cow-pox does not predispose the patient to any affection. 3. There is no relation between typhoid fever and small-pox. 4. The vaccine matter after a time loses its anti-variolic properties. 5. The vaccine matter is a better preventative of small-pox than the variolous matter. 6. Vaccine matter should be renewed. 7. Predisposition to small-pox is greater among the young and aged than among the middle-aged. 8. Revaccination is essential. 9. Even those who have had small-pox should be vaccinated. 10. In passing through the organism, the vaccine matter borrows certain of the matters from the constitution; vaccination, therefore, from arm to arm may be objectionable. 11. The febrile state is unfavourable to the satisfactory action of the vaccine matter.—Vide *L'Institut*, July 3.

Secondary Electro-motive Power of Nerves.—The memoir which Signor Matteucci has published is likely to throw light on some of the obscure phenomena of secretion. The Italian physiologist finds that this secondary force is far more powerful, and exerts a more decided influence, in chemico-vital operations than is generally believed.

Section of the Pneumogastric Nerves.—In a paper read before the *Société Philomathique* of Paris, M. Vulpian has shown that unless both nerves are divided at the same time the consequence is not fatal. He states that no danger follows section of the pneumogastric nerves when an interval of a few weeks is allowed to elapse between the section of the right nerve and that of the left one. He reports the following experiment:—On October 5, 1865, I divided the right pneumogastric nerve of a dog in the middle of the neck, and then brought the two ends together with a suture. On March 15, 1866, I performed a similar operation on the left nerve. The results of the operation were vomiting for about a fortnight, and restoration to health in a month after the operation.—Report of Meeting of *Société Philomathique*, August 3.

A New Theory of Tuberculosis.—M. Lebert has just stated the singular hypothesis that tuberculosis is caused by a constriction of the pulmonary artery.

Experiments on Inflammation of the Liver.—The experiment of Herr Holme is an erroneous one. He draws a silk thread through a living animal's liver. After a few days he removes it, and examines the cells adherent to and entangled in its filaments. From the results obtained by microscopical examination of these he comes to the conclusion that, in the liver,

inflammation makes most progress along the line of hepatic cells, and is less or more impeded by the connecting tissue.—Vide *L'Institut*, August 28.

Experiments on Inflammation of the Trachea.—M. W. Reitz, of St. Petersburg, has published a paper on the croup-like inflammation of the trachea (windpipe) produced artificially. The experiments made by the author are of interest. The membrane was irritated artificially, and the inflammation followed the irritation in about half an hour. The first effect was the production of a series of new cells, which, according to the author, were evidently derived from the epithelium of the trachea. Subsequently there occurred coagulation of fibrine in the interstices of these cells. Thus there was formed a network of delicate filaments, whose meshes contained cells. These cells, when separated by means of needles, and examined under the microscope, were found to be simple spherical bodies unprolonged into filaments, as is sometimes seen. It was found that at a later period the tracheal rings became also more or less affected.

Poisonous Action of Bromide of Potassium.—The experiments of MM. Eulenberg and Guttman show that the action of bromide of potassium is upon the heart, which, in larger doses, it paralyzes. These physiologists injected a solution of the bromide, containing 2 to 4 grammes (from 30 to 40 grains troy) beneath the skin of dogs, and found it produce considerable disturbance of the heart, together with diminution of sensibility, and of the power of voluntary movement. Death followed in from ten to forty minutes, being caused invariably by paralysis of the heart. This result was confirmed by a large number of experiments on frogs and other animals.

Liebig's Food for Infants.—The statement made to the French Academy some weeks since concerning Baron Liebig's soup for children was likely to injure the reputation of this excellent form of artificial diet. M. Depaul alleged that four children, fed from their birth with Liebig's food, had all died from its effects. The Academy, having communicated with Baron Liebig, received the explanation of the deaths. The food had been improperly prepared. As the preparation is, therefore, one of importance, we are glad to see that all the difficulties and possible errors are fully gone into in a recent paper by Herr Pfeuffer. This paper is styled *Liebig's Suppe für Säuglinge*, and is published in *Aerzliches Intelligenz-Blatt*, No. 31.

Does Mercury produce Increased Secretion of Bile?—This was the question asked, but not answered, by a committee formed last winter in Edinburgh. The committee was composed of Professors Christison and MacLagan, of the Edinburgh University; Dr. Rogers, formerly of St. Petersburg; Dr. Rutherford, Gamgee, and Frazer, assistants in the Edinburgh University; and Professor Bennett, the Chairman and Reporter. After studying all that had been previously published by authors (an account of which was furnished by Dr. Rogers), the Committee proceeded to make further experiments on dogs, the animals which had been found best fitted for the purpose. These experiments were carefully conducted by Drs. Rutherford and Gamgee, occasionally assisted by Dr. Frazer, and superintended by the Committee. Professor Bennett gave the results of four series of experiments as to the amount of bile secreted, with and without mercury. In each case the weight of the animal was ascertained, a tertiary fistula formed, the amount of food ascertained and analysed, and the secretion of bile for twenty-four

hours measured, and its solids and salts ascertained. Tables were exhibited in which the results arrived at were estimated in relation to each kilogramme of dung and of food. The greatest variations were found to exist in the amount of bile secreted daily, independently of the amount of food or other obvious cause. The same fact was observed when mercury was given. No conclusions, however, were drawn, as further researches were required before so intricate and difficult a subject could be sufficiently investigated.—*Vide Report presented to British Association.*

Influence of Heat on Muscular Contraction.—A very valuable paper has been laid before the French Academy by M. Chmoutevitch, in which the author shows that heat has a greater effect on the determination of muscular contraction than is generally supposed. M. Chmoutevitch conducted his experiments on the gastrocnemius of the frog, and has arrived at these conclusions:—1. The mechanical power of the muscle increases up to 30° to 33° (Centigrade?), according to its length and tension. 2. If the temperature be raised above 33°, the power of the muscle diminishes, until, as the temperature becomes higher, a point is arrived at which may be called the zero of work. 3. In experimenting with two muscles which, in all but temperature, are under like conditions, it is found that the one submitted to the higher temperature loses its power of contraction more rapidly than the other. 4. The total work of a muscle (represented by the weight it can sustain) is always greater at a low than at a high temperature. 5. The explanation of the increase of mechanical work during the elevation of temperature is found in this fact, that the elasticity of the muscle increases with the temperature.

Is there Animal Electricity?—M. Schultz-Schultzenstein answers, there is not. According to this savant, the researches of Matteucci, Dubois, Reymond, Remak, Radcliffe, and others are valueless, and arose out of a blunder (!). M. Schultzenstein believes that the electric indications which have been attributed by physiologists to the vital action of the tissues, are simply the consequence of the salt and water used in their experiments. He is somewhat dogmatic in the expression of his opinions, and among other startling statements occurs the assertion that "*l'électricité animale est une illusion.*" He lays down the following conclusions:—1. The supposition that living muscle produces electricity is incorrect. If needles be plunged into the foot of a living animal and be placed in communication with the galvanometer no deflection of the needle occurs.—2. Muscles removed from the body give evidence of electricity, but this is because of the combination of the decomposing tissue with the oxygen of the air.—3. Salt water causes the galvanometer needle to be very decidedly deflected. This explains why meat like pork which is salted gives evidence of electricity.—4. The supposed electric current in the human muscle is solely caused by the salt water in contact with the tissue.—5. In diseased structures the electric current is derived from the decomposing tissues.—6. The electricity of the secretions is similarly produced.—*Vide Comptes Rendus*, August 26.

A Photo-sphygmograph.—At the meeting of the French Academy, on the 19th of August, M. Ozanam gave a description of a new contrivance, somewhat like that employed in an observatory, for registering the movements of the pulse. It is a modification of M. Masey's Sphygmograph, a tube of mercury being substituted for the indicator. The pulsations being communicated

to the column of mercury, the elevation and depression of this latter throw shadows on a revolving sheet of photographic paper and are thus recorded.

The Coagulation of the Blood.—With a degree of moral courage which we fear few of our savants would venture to show, Dr. Richardson has withdrawn his theory of the coagulation of the blood. At the meeting of the British Association he announced that recent research showed the ammonia hypothesis to be no longer tenable, and he therefore begged to withdraw it. Experiments which he had lately made on the influence of extremes of heat and cold on albuminous and fibrinous fluids, have shown to him that the process of coagulation in these fluids is due to a communication of caloric force to them, and to a physical or molecular change, determined by the condition of their constituent water. Thus all substances which possess the power of holding blood in the fluid condition, through fixed alkalies, various soluble salts, and volatile alkali, in every respect act after the manner of cold. They render latent so much heat, and in the absence of that heat the fibrine remains fluid. In the opposite sense, every substance which combines with water and produces condensation, with liberation of heat, quickens coagulation. The direct effects of heat and cold illustrate the same truth, and upon these facts turn the differences of coagulation in animals of different temperatures. Those of our philosophers who work for reputation alone (not a few), may think a recantation like that of Dr. Richardson's rather a perilous proceeding. To some small minds it may seem so. We venture to believe, however, that the step Dr. Richardson has taken redounds in the highest manner to his credit, and we believe that it will only add another honour to a name which has always been associated with that honest pursuit of science which results from an earnest desire to discover truth.

Vulpian's Experiments on the Heart.—M. Vulpian lately described to the *Société Philomathique* his curious experiments on dogs. These experiments were conducted with a view to ascertain the mode of origin and cause of inflammation of the heart. In each case the animal was laid on its back, and the flesh having been opened with a scalpel just over the point at which the apex of the heart strikes the chest, a trochar was driven into the cavity of the heart. This being effected, small portions of copper wire, pieces of wood, and so forth, were introduced into the heart, and the instrument was then removed. The animals being then released, some of them died and some recovered. Post-mortem examination showed that in both cases the wires had penetrated the substance of the heart, and in others had been forced by the blood-current into the arteries, in some of which their further passage was obstructed. In one instance, the copper wire lodged in the subclavian artery, and produced a well-marked endo-arteritis, consisting of a softening of the walls, fissure of the inner membrane, and a sort of vegetation. —Report of meeting of the *Société Philomathique*, July 6.

The cause of Osteomalacea is thus explained by M. Drivon in a paper published in the *Gazette Médicale de Lyon*, for July:—The diseased bones contain lactates, and probably lactic acid in considerable quantity; these help to dissolve the earthy carbonates and phosphates, which being then resorbed, produce the softened condition characteristic of this malady.

The Poison of the Spotted Salamander.—The poisonous substance of the

secretion of the *Salamandra maculata* has been chemically examined by M. Zalesky. M. Zalesky has succeeded in isolating the active principle, which is an amorphous colourless mass soluble in water. M. Zalesky calls it *salamandrine*, and states that it possesses, in an intense degree, the poisonous properties of the secretion from which it is extracted.

METALLURGY, MINERALOGY, AND MINING.

Aluminium Bronze in Machinery.—M. Hulot, of the French Imperial Mint, has called attention to the fact that the perforating tools employed in the division of postage-stamps are rapidly blunted by the gum used to render the stamp adhesive. Indeed, so rapidly is the effect produced, that after a few hours' work the tools, instead of piercing the paper, only crush it. M. Hulot replaces the steel by aluminium-bronze at 10 per cent., and the new tool, striking 126,000 blows per day, or 180,000,000 holes, has worked for several months without need of repairs. Aluminium-bronze does not unite freely with solder by the old process; but if we take equal quantities of zinc-amalgam and common solder, aluminium-bronze can be admirably soldered together by it. This solder becomes better, again, if it is alloyed with once or twice its weight of tin. Thus there are three excellent solders—1st, solder with half its weight of amalgam; 2nd, with a fourth; 3rd, with an eighth.

The Manufacture of Zinc.—A paper on the relative value of the Belgian and Silesian processes for the manufacture of zinc has lately appeared in the *Berg- und Hütten-Zeitung* (1867, No. 24). From this it appears that the Belgian furnaces, with sixty retorts, in seven or eight horizontal rows, require less fuel, have a more intense heat, a quicker process, and a greater yield, than the Silesian apparatus. On the other hand, the Silesian furnaces require less skilful workmen, but burn a smaller quantity of coal. The Silesian process extracts more zinc from the ore, whilst the Belgian furnaces have for a given time a greater productiveness. When the ore forms tough slags, the Silesian method is preferable.

The Economisation of Sulphurous Acid in Copper Smelting.—At the late meeting of the British Association, Mr. P. Spence gave an account of a process for saving the sulphurous acid, which seems likely to come into use. The following is the plan adopted:—In the calcining furnace sulphur and arsenic are dissipated into the air, but a portion of the sulphur remains, which in the smelting furnace sinks below the silicate of iron, to be run off with the copper, and afterwards, when the regulus is again calcined, more of the sulphur is given off. By catching this vapour of sulphur in a draught of heated air passed along the furnaces, the sulphurous acid which is formed is introduced into the leading chambers, when it is converted into sulphuric acid.

The Perseberg Iron Mines, Sweden.—Dr. C. Le Neve Foster read a paper on the above, before the British Association at Dundee. The author described some important deposits of magnetic iron-ore which are now being worked near Philipstadt, in Sweden. The ore occurs in beds, which follow

the various contortions of the surrounding rocks. It is found in Hälleflindt—a rock which is considered by the Swedish geologists to be a compact variety of gneiss. The ore is always accompanied by a rock consisting of garnet, hornblende, augite, and epidote. The author compared the large deposits of Perseberg to a deposit at the Crown's Rock, Botallack Mine, near St. Just, Cornwall, where magnetite is accompanied by the same minerals, and occurs under the same conditions as at Perseberg, only on a much smaller scale.

Analysis for Black Spinnelle.—At one of the recent meetings of the French Academy, M. Pisani gave the results of his analysis of a black spinelle from the Haute Loire. The specimen was remarkable from its crystalline form, which was that of an octohedral pyramid, and it is found also in the igneous rocks of Auvergne. The following is its composition:—

Alumina	.	.	.	.	.	.	.	59.06
Ferric oxide	.	.	.	.	.	.	.	10.72
Ferrous oxide	.	.	.	.	.	.	.	13.60
Magnesia	.	.	.	.	.	.	.	17.20

Copper-Nickel Alloy.—The following method for the production of this alloy has been described by M. Stromeyer in a late number of the *Chemical News*, and is that in general use at Dittenburg Nassau:—1. *Raw melting*: roasting the ore, and smelting it to coarse metal. 2. *Concentration melting*: roasting the coarse metal, and smelting it to concentration of a regulus. 3. *Refining melting*: separation of the iron from the concentrated regulus. 4. *Roasting and reducing process*: transformation of the regulus into oxides of copper and nickel by roasting, and the reduction of the latter to copper-nickel. The further details of the processes will be found in the *Chemical News*, August 2.

Composition of Specular Iron.—The following result of the analysis of the iron used for cast-steel cannons has been given in a German chemical journal. The specimen was dissolved by electrolysis in hydrochloric acid:—

Carbon	.	.	.	.	.	.	.	3.758
Iron	.	.	.	.	.	.	.	87.997
Manganese	.	.	.	.	.	.	.	6.555
Phosphorus	.	.	.	.	.	.	.	0.578
Silicon	.	.	.	.	.	.	.	0.497
Sulphur	.	.	.	.	.	.	.	0.171
Calcium	.	.	.	.	.	.	.	0.127
Copper	.	.	.	.	.	.	.	0.120
Arsenic	.	.	.	.	.	.	.	0.118
Magnesium	.	.	.	.	.	.	.	0.052
Antimony	.	.	.	.	.	.	.	0.027
Silver, lead, bismuth	.	.	.	.	.	.	.	trace.

Vide *Annalen der Chemie*, bd. 140, p. 180.

Russian Mineralogy.—The French Academy has been presented by M. Kokscharow with the fifth volume of his *Materialien zur Mineralogie Russlands*.

Petroleum for Steam Engines.—Some experiments have been lately made in America which seem to show that petroleum has many advantages as a fuel over coal. A gunboat called the Palos was used for the experiments. She had been built for the Government, to make a speed of eight knots an hour, and with coal could never be forced beyond that. First she was tied to the dock, and the possibility of getting-up steam with petroleum was demonstrated. She was then sent on a trial trip down the harbour. Steam was got up with petroleum in 25 minutes, and the Palos steamed down the harbour and back, a distance of 25 nautical miles, in 1 hour and 55 minutes. In making this trip she consumed but four barrels of petroleum. The fires are reported to be kindled and extinguished with nearly the same ease as lighting and extinguishing a gas-burner. The furnaces of the Palos, originally built for burning coal, were fitted at comparatively small expense with burners, to which the petroleum was led by pipes from the tanks on deck. The burners, by their own heat, turn the petroleum in the pipes into gas, and in this form it is burnt. The flames produced are intensely hot, and the petroleum burnt on the trip produced as much steam as 20 times its bulk in coal—a great saving of room in ocean voyages. The dangerous properties of the petroleum appear to be the only drawback to its use in this way, for coal-burning furnaces can be adapted to its use at but a trifling expense. The supply of petroleum is now so much greater than the demand that, even with three-fourths of the wells in the producing regions abandoned, it can be bought for 2d. a gallon. Its cheapness is, therefore, another strong inducement to use it for generating steam.

Anticrustation Mixture for Boilers.—The following recipe is given in a number of *Elser's chemisch-technische Notizen*:—125 kilos. of crystallised chloride of barium dissolved in 50 kilos. of water with addition of 25 kilos. of hydrochloric acid (specific gravity 1.20). To every 1000 litres = 1 cubic metre = 35.5 cubic feet English, 15 litres of this acid solution should be applied.

Constitution of Fire-Clays.—In a paper published in a late number of *Silliman's Journal*, Messrs. Johnson and Blake state that compounds, such as pipe-clay, fire-clay, and kaolin, all contain a peculiar crystalline substance, which they term kaolinite. Seen under the microscope by reflected light these clays appear white, but when the light is sent through them they appear translucent. Interspersed among the particles may be seen curiously plate-shaped particles 0.0001 of an inch in breadth.

Blast Furnace.—It is stated in the *Revue Universelle* that Morgan's method of increasing the production of blast-furnaces sixfold, is by giving them greater dimensions, for instance, 9½ mètres in diameter, blowing into the furnace by 12 tuyeres. A hollow cone is besides constructed in the middle part of the bottom of the furnace, by means of which a blast is also introduced into the furnace.

Artificial Gold.—The alloy bearing this name has recently attracted some attention in this country from the supposition that its employment is likely to benefit on tin and copper workers. A contemporary gives the following account of it:—It is composed of pure copper, 100 parts; pure tin, 17 parts; magnesia, 6 parts; tartar of commerce, 9 parts; sal ammoniac, 3.6 parts; and quicklime, 1.6 part. The copper is first melted, then the

lime, magnesia, sal ammoniac, and tartar are added, little at a time, and the whole is briskly stirred for about half-an-hour, so as to mix thoroughly, after which the tin is thrown on the surface in small grains, stirring until entirely fused. The crucible is now covered, and the fusion kept up for about thirty-five minutes, when the dross is skimmed off, and the alloy found ready for use. It is quite malleable and ductile, and may be drawn, stamped, chased, beaten into powder, or into leaves, like gold-leaf. In all of which conditions it is not distinguishable from gold even by good judges, except by its inferior weight. The alloy has already been largely applied in the United States, and requires only to be known in Great Britain to become a favourite.—Vide the *Engineer*, July 19.

METEOROLOGY.

Classification of Meteorites.—A classification of meteorites which will be found useful by those engaged in the study of these bodies, has been given by M. Daubrée in a paper read before the French Academy in July. M. Daubrée divides all meteorites into two primary groups, *Siderites* and *Asiderites*—the former being characterised by the presence of metallic iron, and the latter by its absence. The Asiderites contains one group only, which is termed *Asideres*. The Siderites are divided into two sections: in the first the specimens do not enclose stony particles, and in this we find the group of *Holosideres*; in the second both iron and stony matter are present. This, then, includes two groups: *Syssideres*, in which the iron is seen as a continuous mass; and *Sporadosideres*, in which the iron is present in the form of scattered grains.

A Town without Ozone.—From the experiments which have been made since 1852 by the Hydrometric Commissioner of Lyons it would appear that the atmosphere of this town is devoid of ozone. The results more recently arrived at by the officials of the Imperial Observatory point to the same fact. The observations conducted by these workers have not yet been published in full. Meanwhile, M. Fournet gives the conclusions arrived at by his resumed observations at Lyons and the suburbs, with the co-operation of M. Lambert and Rassinier. While ozone was very abundant at Sauvage, on the heights of Tararre, a range of hills separating the basins of the Loire and Rhone, traces were barely perceptible once or twice a month at Lyons. It is well known that it has been often maintained that the arrival of the cholera was coincident with the disappearance of ozone in the air. The example of Lyons does not agree well with this assertion: this city is not subject to cholera, and, at the same time, its atmosphere is always deprived of oxygen.—Vide Foreign Correspondence, *Chemical News*, July.

Rainfall of the 16th July.—In his "Magazine" for August, Mr. Symons dwells upon the more remarkable features of this severe rainfall. Without attempting to explain the fact that in some localities the rainfall was twice that of others, at a distance of a few miles, he gives the more striking examples. For instance, twice as much rain fell at Deptford as at Camden Town, one having 4 inches and the other $2\frac{1}{2}$, the distance between the two being only seven miles. Again, at Maidstone, the fall was equal to 2·7

inches, while at Linton Park, seven miles off, the fall was 1·5 inches. At Hartlip the gauges recorded over 5 inches of rain; but at Tong, a distance of six miles, the records show a fall of only 1·64. As we have said, Mr. Symons does not explain these singular differences between the rainfall of contiguous stations, but we think the fact may depend on the same principle as the ordinary snow-drift.

Hurricanes of the Indian Ocean.—At the meeting of the British Association, Mr. Meldrum read a paper pointing out facts of considerable meteorological interest. After showing how these hurricanes originated between the S.E. trade wind and N.W. monsoon, how the wind in them rotated from left to right, or with the hands of a watch, how they travelled at first to S.W. and then curved to S. and S.E., Mr. Meldrum alluded to their form, showing that the wind blew spirally, and illustrated the subject by interesting quotations from the log-book of the Earl of Dalhousie, a vessel which, he believed, belonged to the port of Dundee, and which in May 1863 had scudded round and round the centre of a revolving storm three times, at the rate of 10 to 13 knots, nearing the centre as she went round it. As the S.E. trade wind frequently blew strongly over many degrees of longitude during a hurricane, with a falling barometer, it was impossible to know the bearing of the centre when a vessel was in front of a storm, and at some distance from the centre, and Mr. Meldrum could adduce instances of great loss of life and property arising from vessels in those circumstances adopting the recommendation usually given of running to the westward or north-west. It could not also be made too widely known that a large portion, perhaps the largest, of the losses caused by hurricanes in those seas arose from the fact that homeward bound vessels took apparent advantage of increasing N.E. winds between 10° and 16° S. and, running to the south-west, got in front of the storm, in which they were often dismasted, if they did not founder; whereas, by lying to for a few hours, or proceeding cautiously to the southward, the storm would have been avoided.

Singular Effects of Lightning.—Sir David Brewster has published an account of the effects of lightning in Forfarshire which is of much interest. In the summer of 1827 a hay-stack was struck by lightning. The stack was on fire, but before much of the hay was consumed the fire was extinguished by the farm servants. Upon examining the hay-stack, a circular passage was observed in the middle of it, as if it had been cut out with a sharp instrument. This circular passage extended to the bottom of the stack, and terminated in a hole in the ground. Captain Thomson, of Montrose, who had a farm in the neighbourhood, examined the stack, and found in the hole a substance which he described as resembling lava. A portion of this substance was sent by Captain Thomson to Sir David's brother, Dr. Brewster, of Craig, who forwarded it to Sir David, with the preceding statement. The substance found in the hole was a mass of siliceous material obviously formed by the fusion of the siliceous material in the hay. It had a highly greenish tinge, and contained burnt portions of the hay. Sir David presented the specimen to the museum of St. Andrews.

Observations on Atmospheric Electricity.—The observations made at Kew on this subject have been contrasted by Professor Everett, of Nova Scotia, with those made at Windsor, N.S. The Kew observations referred to extended from June 1862 to May 1864, inclusive, and were taken with Sir

Wm. Thomson's self-recording apparatus, specimens of the photographic curves thus taken being exhibited at the meeting. The Windsor observations, taken by Dr. Everett with apparatus of a different kind, also invented by Sir Wm. Thomson, but not self-recording, extended from October 1862 to August 1864. Monthly averages which had been taken showed that at Kew there had in every month been two maxima in the day—one of them between eight and ten A.M., and the other, which was more considerable, between eight and ten P.M. At Windsor, on the contrary, the electricity between eight and ten P.M. had in every month been weaker than either between eight and ten A.M. or between two and three P.M. The annual curve for Kew had its principal maximum in November, and another in February or March. At Windsor the principal maximum was in February or March, and the minimum in June and November. The annual curves for the two places agreed pretty well from January to October, but were curved in opposite directions from October to January.

A New Test for Ozone.—In the *Comptes Rendus* for July, Admiral Berigny records numerous experiments upon the correct methods of detecting ozone in the atmosphere, and states that he has found protoxide of thallium the most delicate test. While, for example, ordinary oxygen produces little effect on papers saturated with solution of this substance, ozone instantly reveals its presence by giving a brown tint to the paper. Unfortunately, however, for the practical usefulness of the new test, it is found that carbonic acid affects the protoxide of thallium in the same manner as ozone. Hence, the discovery has little more than a purely theoretical value.

Relation of Ozone to Direction of Wind.—The results arrived at by observations made at sea by Mr. W. F. Moffat, R.N., and reported by Dr. Moffat to the British Association, are very remarkable. It was found that as the wind veered with increasing readings of the barometer from south points of the compass through W. to N., ozone disappeared, and continued absent while the wind was in points between N. and E., and that it reappeared as the wind veered with decreasing readings of the barometer to S. points. The disappearance and reappearance of ozone with those conditions were so regular, that the changes appeared to be the result of an invariable atmospheric law, and Mr. Moffat was induced to examine the law of rotation of the wind, so clearly developed by Dove, and the results of the examination led him to believe that the polar current is the non-ozoniferous, or that of minimum of ozone, and that the equatorial is the ozoniferous, or that of the maximum of ozone. According to the rotation theory, the N. polar current forms the N.E. "Trade," and the S. polar the S.E. "Trade," while the equatorials form the northern and southern hemispheres to upper or returning "Trades." These returning "Trades" come to the earth's surface in the northern and southern hemispheres about the 28° or 30° of latitude—the latitude varies with the season—N. and S. of the equator. If these deductions are to be relied upon, the N.E. and S.E. "Trades" ought to be the minimum of ozone currents, and the returning "Trades" the maximum of ozone currents, the one in the northern hemisphere forming the S.W. wind, and the other in the southern hemisphere a N.W. wind.

MICROSCOPY.

New Class and Demonstrating Microscope.—In teaching histology to large classes of students, two forms of microscopes are required: one for the laboratory, with which the student himself works, and one for the class-room, which the lecturer hands to the nearest student, who passes it to his neighbour, and so on till it travels round the class. The idea of combining these two forms in a single microscope occurred to us as being both economical and convenient. The instrument represented in the adjoining cut was therefore prepared for us by Mr. Collins, of Titchfield Street. Fig. 1 represents the microscope as used in the laboratory, with a double nose-piece bearing a 1-inch and $\frac{1}{4}$ -inch object-glass. Fig. 2 shows the microscope as used in the

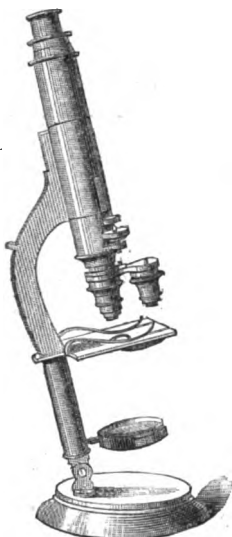


Fig. 1. As used in the Laboratory.

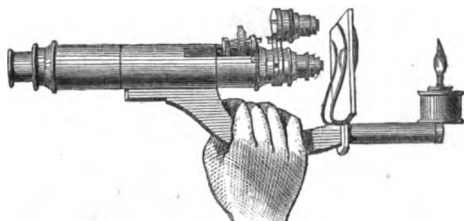
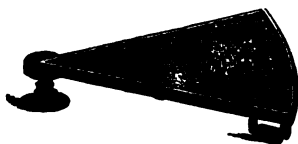


Fig. 2. As used in the Lecture-room.

NEW CLASS AND DEMONSTRATING MICROSCOPE.

lecture-room: the leg is drawn out from the sliding tube, which works in the knuckle joint in the solid metal foot, and bears the mirror; on this there is fitted a small oil-lamp, and the instrument being grasped by the curved portion between the body and stage, and used like a telescope, transparent objects placed on the stage are seen with the greatest distinctness. It is remarkable, but it is no less true, that no amount of ordinary flickering of the flame is perceptible by the observer. The instrument is provided with a good 1-inch and also $\frac{1}{4}$ -inch objective, which show the markings on *Pleurosigma formosum* most satisfactorily. The instrument is intended to meet the want of teachers in medical schools and public institutions, and has just been selected for the histological laboratory at St. Mary's Hospital.

An Adjustable Rotating Microscope-table has been devised by Messrs. Loam and Fearn, and is likely to be useful to those who use a circular table when exhibiting microscopic objects to a number of persons.



NEW ROTATING MICROSCOPE TABLE.

It is triangular in form and, when placed in position, its apex corresponds to

the centre of the table on which it rests ; at its base it rests on two rollers, and its apex swings on a vertical pivot. When, therefore, the microscope and lamp are placed on this "rotating table" and adjusted to each other, the two may be sent round from one observer to another, as in a roulette-board. The pivot being movable, the rotating table can be made of any radius, and can then be adapted to the size of the loo-table on which it is placed. Amateur microscopists will do well to provide themselves with this little addition to the list of microscope accessories.

A Telescopic Lamp.—A microscope lamp, which may be found convenient, has been constructed by Messrs. Murray and Heath, of Jermyn Street. In



TELESCOPIC MICROSCOPE LAMP.

the form of the lamp itself there is little new ; but the stand is peculiar. It consists of three telescopic sliding tubes, the innermost of which is the cylinder which contains the oil. The object of this arrangement is that, without the ordinary contrivances, the light may be elevated or depressed. The tubes are provided with a screw-thread which prevents the lamp from descending from the point at which it is fixed.

A Pocket Microscope of a very cheap description has been constructed by Messrs. Frith. It is intended to be used by amateurs in the examination of mites and "wheel insects." It is simply an extremely small lens, whose corrections are imperfect. This is approximated by a screw to a glass disc on which the object is placed. The makers' description will interest readers who are versed in microscopical terminology. It states that the instrument is divided into four parts, viz., "the Eye-piece, composed of two screws in the centre, between which is placed the lens, or magnifying glass; 2nd—the Object-glass, on the centre of which the objects are placed, and which is fixed to No. 3, or the body or tube; 4th—the Condenser of natural light, at the extreme end, which must be used only by daylight and taken off by gaslight, when the observer must point the open end of the tube towards the gas or candlelight, to receive the rays direct." We may state that the condenser is simply a diaphragm, with an aperture of $\frac{1}{4}$ inch diameter.

PHOTOGRAPHY.

Improved Process for making Photographic Transfers.—Amongst recent patents connected with photography is one taken out by Mr. G. Morvan, of New Jersey, U.S., for making transfers to lithographic stone, &c. A negative being obtained from the design, it is printed by light on paper prepared as follows:—A suitable paper, albumenised or not, is placed in a bath of sour milk, for the purpose of giving it greater strength and solidity. When taken from this, it is allowed to dry at an ordinary temperature, and is coated with the following material: half a pound of French glue dissolved in a pint of water, added while boiling to a solution of one-third of an ounce of permanganate of potash in a quart of water, and used cool. The paper thus coated is dried in the dark, and exposed under the negative. After removing, and before developing, cover the first coating with another composed of equal parts of bitumen, white wax, and Burgundy pitch, dissolved in a sufficient quantity of essence of lavender to allow of its being spread smoothly over the surface. Let this also dry in the dark; after which place it with the black side upwards in a bath of cold water, which dissolves those parts on which the light has not acted, and carries with it the superincumbent mixture of wax, bitumen, and Burgundy pitch. The proof is finished by a few strokes of a sponge, and, when dry, can be transferred to lithographic stone, or to zinc or other metal, by contact and pressure in the ordinary manner; to be printed from, if on stone, and to be engraved with acids on the metal, the composition protecting the parts it covers from the action of the etching fluid.

Photography by Artificial Light.—Professor Falkland, in the course of some lectures on coal gas, delivered at the Royal Institution, pointed out the value of a new and intensely brilliant light to which photographers have recently had their attention directed, as being very actinic and manageable, and in other ways peculiarly fitted for photographic uses. Bisulphide of carbon warmed until it gives off vapour freely, is ignited, when it burns

with a pale blue flame giving a feeble light. A jet of gas, obtained by the action of nitric acid on copper, being allowed to play through this burning vapour, the result is a very brilliant actinic light, which can be kept up for a considerable time with a very small amount of trouble. It must be remembered, in using this light, that the burning bisulphide of carbon gives off fumes of sulphurous acid.

The Nature of the Latent Image.—In our last we gave what were called "some entirely new views" on this subject, as advanced by an American, Mr. Carey Lea. This gentleman has since been very active in promulgating his theory; and although it has been very clearly shown in the English journals to which he contributes that, as we suspected (see note page 344), he has no claim to be regarded as the originator of such views, still, in the American journals, he continues to assume the position of one who first communicated them to the public, and to strangely exaggerate their importance. Mr. W. H. Harrison laid claim to having first published the ideas Mr. Lea pertinaciously claims as his own, and a controversy ensued, in which the latter gentleman strove to show that Mr. Harrison's views entirely differed from his own, and that they were false, basing his argument upon the assumption that Mr. Harrison held the action of light to be simply an augmentation of the amplitude of the *ordinary* vibrations of molecules composing the sensitive surface—an assumption not warranted by Mr. Harrison's remarks. At an early stage of the controversy, Mr. Harrison gracefully withdrew his claims to priority of publication in favour of Mr. Mungo Ponton, F.R.S.E., who, in reply to Mr. Lea, says * "The vibrations which we (himself and Mr. Harrison) suppose to be effected by the light, are not the ordinary vibrations between molecule and molecule of the sensitive compound incident to its temperature; but a totally distinct set of very minute vibrations established between atom and atom of the constituent of each molecule of the substance. Whether such minute vibrations exist at all before exposure to the light, is unimportant; but it is evident that the greater the motive energy of the light brought to bear upon them, the greater will be the amplitude of those vibrations; consequently the greater will be the facility for effecting a separation between the atoms. The *rate* of vibration is a different affair, and will depend on the nature of the constituent atoms, and the strength of the chemical attraction by which they are held together. The more nearly the natural rate at which these atoms tend to vibrate approaches to the rate of the violent waves, the more readily will they take up the motion from those waves and have their amplitude thereby enlarged. But their rate will not be altered by the energy which they absorb from the ethereal waves; while, even if it were quickened, such acceleration of the rate could not produce any increased tendency to decomposition. An increase of motive energy can affect a vibration in only one of two ways: it must either quicken its rate, or enlarge its amplitude. Now the doubling or even the trebling of the rate of vibration between two heterogeneous atoms constituting a compound molecule, could have no effect in promoting their permanent separation; but every increase in the amplitude of the vibration

* In the *British Journal of Photography*.

removes the one atom to a greater distance from the other, at the moment of farthest departure from the point of rest; while such an increase of distance must produce a corresponding momentary weakness in the attraction by which the two atoms are held together, so rendering more easy their permanent separation. The tendency to separation would also be increased by a lowering of the rate of vibration simultaneously with the increase of amplitude, because it would prolong the moment of weakest attraction. It is obvious that no augmentation in the amplitude of those ordinary vibrations of the molecules of a compound body which are incident to its temperature could produce the same effect; because the atoms of each molecule are not in this manner made to vary their distance one from another. . . . In order that the vibrations between the atoms constituting a compound molecule may have their motion amplified by those of the lumiferous ether, it is not necessary that the latter should be *exactly* synchronous with the natural rate at which the atoms tend to vibrate, although the more nearly they are synchronous the more effective they will be. Where we have 800 billions of vibrations in a second, a few millions more or less can be of little importance." Mr. Ponton concludes that the action of light in fluorescence, is quite different from what it is in photography. "In fluorescence, the molecules, or their constituent atoms, on taking up the motion from the ethereal waves, change its rate. The incident light is absorbed and a new set of ethereal waves is propagated by the vibrating atoms or molecules, and these new waves have a rate of vibration slower than that of the incident waves; hence the colour corresponds to these more leisurely vibrations; hence, also, incident ethereal waves too rapid in their rate of vibration to affect the optic nerve, may stimulate the molecules or atoms to propagate waves of that slower rate of vibration which is capable of exciting the nerve into action. The waves whose vibrations are thus appropriated and lowered in their rate by the fluorescent body, are those most active in photography; and hence fluorescent surfaces are photographically inert, the waves which they propagate being of too slow a period to be effective in this manner. The continuance of the vibratory action, after the exciting light has been removed, is similar to phosphorescence. Every motion once begun has a tendency to continue till checked by some retarding force. It is, therefore, not at all wonderful that the vibrations between the constituent atoms of the molecules of the sensitive substance should continue for a considerable time after being removed from the excitement of the light. The phenomenon is of the same nature as the retention of its heat by a body for a considerable time after it has been taken out of the fire." * At an earlier stage of the controversy, other views were advanced, but we have not space for further particulars.

Awards of Photographic Jurors at the Paris Exhibition.—We give a list of the English photographers who have carried off honours at the Paris

* E. C., writing in the *British Journal of Photography*, in reply to the above statement, asks: "How is it, then, that dry plates have been developed several years after exposure, and commonly months afterwards, without more than ordinary difficulty? It is evident that in the film the 'excitement' must still be kept up *without appreciable diminution*."

International Exhibition. Messrs. Bedford, England, Mudd, Thurston, Thompson, and Robinson were each awarded a silver medal for landscape photographs. Figure and portrait photographers were not recognised as worthy the silver medals, and therefore received medals in bronze. The names of those thus distinguished are Messrs. Blanchard and Mayall, the latter award being for enlargements from small negatives. Bronze medals were also awarded to Messrs. Griggs, Col. Briggs, Bourne and Shepherd, Macfarlane, Heath, Col. Stuart Wortley, and White, for landscape photography. For cabinet work a bronze medal was awarded to Meagher, and for lenses to Mr. T. Ross; Mr. Cherril received a bronze medal for carbon prints, Caldesi one for medallion photographs, and M. Joubert one for his enamel process. A silver medal was awarded to Mr. Swan for an improved carbon-printing process, to Mr. Woodbury for a new mode of printing, and to Mr. Dallmeyer for a triplet object-glass. The following names were associated with "honourable mention":—Beasley, Bean, Brownrigg, Cameron, Coghill, Cramb, Cruttenden, Grisdale, Hemphill, Hosmer the Pantoscopic Company, Pouncy, Ross (of Edinburgh), Rouch, Royal Artillery, Soloman, H. Swann, Thomas, S. Thompson, Verschoyle, Wardly, and Wilson. There have been, as was to be expected, perhaps, many charges of unfairness and undue partiality brought forward in connection with these awards, and some very striking inconsistencies have been noted; but the worst case published is that which Mr. Thomas Ross has called public attention to, viz., the jurors deciding upon giving a medal for excellence in lenses which they had not examined, simply because they were exhibited by a manufacturer of known repute. This medal, the only one awarded for general excellence in photographic lenses, Mr. Ross generously declined to receive, upon the ground of the injustice of a mode of proceeding which deprived every young and unknown optician of that fair chance in honourable competition which each exhibitor has a right to demand and to expect.

Photography at the British Association.—Photography has not played a very prominent part at the meeting at Dundee, although its productions were used to illustrate papers in most of the sections. Professor J. C. Maxwell, F.R.S., introduced a new stereoscope in section A. The effect of looking through this instrument was very novel and striking. In the ordinary stereoscope the observer applies his eyes to the two lenses, seeing one picture with the left, and the other with the right eye. In Professor Maxwell's the observer stands a short distance from the apparatus and looks with both eyes through the large lens. The instrument consists of a board about two feet long, on which is placed—1. A vertical frame, to hold the side turned upside down. 2. A sliding piece near the middle of the board, containing two lenses of six inches focal length placed side by side, with their centres about $1\frac{1}{4}$ inch apart. 3. A frame containing a lens of about eight inches focal length and three inches diameter. The eye should be placed about two feet from the large lens. With his right eye he sees the real image of the left-hand picture formed by the left-hand lens in the air, close to the large lens, and with the left eye he sees the real image of the other picture formed by the other lens in the same place. The image may be magnified or diminished at pleasure by sliding the piece containing the two lenses nearer to or farther from the pictures. ;

M. Claudet called attention to an improved instrument which is used to equalise the focus of a lens on different planes. Sir David Brewster made some remarks on the enamel photographs of Mr. McCraw, of Edinburgh, and M. Claudet read a short communication on the result of some experiments with non-achromatic lenses of rock-crystal and topaz, the results of which, he said, were very promising, which experiments he had been induced to make by the theory Sir David Brewster published many years since. In Section B, Mr. J. Spiller, F.C.S., read a paper on certain new processes in photography. These processes were the various modifications of Mr. Woodbury's, micro-photosculpture, photolithography as practised in the Royal Arsenal at Woolwich, and a process of printing on silk, satin, or cambric, practised by Mr. H. B. Pritchard, of the War Department.

Action of Light on Honey.—M. Scheibler has attributed the crystallisms of honey to the photographic action of light, and thus explains why bees carefully exclude light from their hives, as, if light obtained access, the syrup on which the young bees feed would, by becoming more or less solid, seal up the cells, and probably prove fatal to the inmates of the hive.

PHYSICS.

Action of Glass Rods in Liberating Gases from Solution.—Mr. Chas. Tomlinson's researches on this point show that the phenomena of liberation of the gas depend, not on any peculiar action in air or gas, but on whether the rods are clean or not. The theory that he proposes to substitute rests on the distinction between a chemically clean solid and one that is clean in the ordinary sense of the word. If the solid be chemically clean, there is perfect adhesion between it and the solution, and there is no liberation of gas; if the solid be not chemically clean, then the adhesion is imperfect, and there is a separation of gas. If the water is not attracted by the solid, the gas is; for although the rod may not be clean enough for water to adhere to it, yet gas will adhere to a dirty or a greasy rod. If the rod be made chemically clean, it soon ceases to be so by exposure to the air; and this circumstance, according to Mr. Tomlinson, has led the numerous writers on supersaturated solutions of salts into error as to the action of *nuclei*, &c., in inducing crystallisation. If the nucleus be chemically clean, the solution wets it perfectly, and there is no separation of salt from the water; if the nucleus be not chemically clean, there is separation.—Vide *Philosophical Magazine*, August.

Influence of Capillary Action on Chemical Decomposition.—M. Becquerel continues his researches on the action of capillarity in chemical decompositions. In his third communication he gave a new set of illustrations of the law already expressed by him. He stated that the phenomena described by him in his earlier papers are due to the influence of three agencies—affinity, capillarity, and electricity. To demonstrate the intervention of electricity, M. Becquerel has made the following experiment: he immersed his *split* bell-glass, containing nitrate of copper, in a second bell containing a solution of monosulphide, as in the first experiments; then he dips the two extremities of a silver wire, one into the nitrate, and the other into the monosulphide. A

constant electric current is formed : (1) The deposit of silver is made not in the capillary slit, but on the iron ; (2) When the wire is removed the deposit is formed in the slit and on the edges along the side of the split bell-glass. The capillary action is as powerful as an electrical action. M. Becquerel continues to improve his experiments ; for the split bell-glass he substitutes prisms of crystal glass pierced with a small hole ; the slit or fissure is replaced by plates of glass with edges in contact, or even by sand : and he has thus obtained effects of silvering, gilding, and platinising.—*Vide Comptes Rendus*, July 1, and *Chemical News*.

A new *Polarising Photometer* was described by its inventor, Mr. W. Crookes, F.R.S., at the British Association meeting at Dundee. He was unable to exhibit the instrument itself, but he gave the following description of it : Two discs, emitting natural—not polarised—light, are placed in front, and at a considerable distance behind is a doubly-refracting prism of Iceland spar, rendered achromatic by a piece of glass, which will separate the light emitted by the two discs into three ; but, for the purposes of the instrument, the outer two must be disregarded. The difference of intensity between the original self-emitting discs is proportioned to the free polarised light found in the central disc of light. This is again split up, and the difference of intensity between the first discs is ascertained from the difference between these final ones. In comparing the light of two stars, Mr. Crookes makes use of Arago's Polarimeter, which, twisted in one direction, gradually cuts off one kind of light, and when twisted in the opposite direction, cuts off the other kind of light, so that the intensity of the light is measured by the angle through which the instrument must be turned.

Recent Memoir on Optics.—Herr Dove, the celebrated physicist and meteorologist, has presented to the Academy of Berlin a memoir in which he discusses the following important points :—1. The formation of white by uniting the colours of the spectrum ; 2. The subjective colours in the electric spark ; 3. The inversions in monocular or binocular vision of perspective drawings or transparent bodies ; and 4. The polarization of light by successive reflections.—*L'Institut*, August.

Improvements in Voltaic Piles.—Certain improvements have been suggested by M. Zaliwski Mikorski. The latest experiments of the physicist show that by increasing the height of the elements without altering their base, a current proportionate to the height may be obtained. He recommends the following method for increasing the energy and permanency of a Bunsen's battery :—Place two porous vessels one within the other : into the first, containing the carbon, pour nitric acid ; into the second, sulphuric acid ; finally, into the outer vessel, containing the zinc, pour sal-ammoniac. There is no effervescence, and the zinc undergoes no useless destruction.

An excellent Popular Illustration.—Sir W. Thomson, in describing a small electrical machine to the British Association, employed the following happy analogy to convey an idea of the purpose and mode of action of the new instrument :—The principle of the machine is that of the "Successful Merchant" who commenced life with a capital of $\frac{1}{2}d.$, and, after a month's persevering industry, realised the handsome sum of 1*l.*, and continued to go on increasing his capital at a compound rate of interest. The object of the instrument referred to is not indeed to increase money but electricity, and

that increase was at a compound rate. Precisely in conformity to the law which applied to compound interest and the increase of the successful merchant's capital is the increase of electricity by this machine. Given the smallest quantity of electricity, and the instrument increased it at the rate of compound interest, and this increase went on at a perfectly uniform rate. But just as the capitalist finds that he cannot always go on getting higher and higher interest for his money, but must ultimately, perhaps, be content with $4\frac{1}{2}$ per cent. instead of 5, so was it to some extent with this machine. When a very high charge was reached, the increase of the quantity of available electricity was not so great, owing to sparks passing in various parts of the machine, preventing the operator from retaining the full quantity of electricity which was got by it. There is great necessity for an easy-going electric machine, and that shown fulfilled this condition.

How the Earth's Rotation affects Gunnery.—Some may be found to doubt that the movement of the earth affects the direction of a ball expelled from a cannon; nevertheless, the fact is correct. In the *Astronomical Register* Mr. Kincaid says that a simple illustration of this effect may be made by attaching to the same axis two wheels of different diameters, so that both shall rotate together. If the one have a diameter of 3 feet, and the other of 1 foot, it is evident that any point on the circumference of the larger will, during a revolution, move through three times as much space as a similar point on the periphery of the lesser circle, and will, therefore, move with three times the velocity. The figure of the earth may be considered as made up of an infinite number of such wheels, diminishing in size from the equator to the poles, and all revolving in 24 hours. Now, if a gun be fired from the equator in the direction of the meridian, which is obviously that of maximum deviation, at an object nearer the pole, it is plain that that object, being situated on a smaller circle than the gun, but revolving in the same interval of time, will move, during the flight of the projectile, through less space eastwards than the shot, which will have imparted to it the greater velocity of the larger circle from which it started, and the latter will therefore tend to strike eastwards from its butt.—*Astronomical Register*, August.

The Physics of a Soap-bubble.—That the physics of a soap-bubble is a difficult problem to work out has been shown by Sir David Brewster's repetition of Plateau's experiments. The changes of form which the films undergo are especially difficult to explain, the ordinary theory being insufficient. Sir David Brewster thinks that the colours of the soap-bubble are not produced by different thicknesses of the film itself, but by the secretion from it of a new substance flowing over the film, expanding under the influence of gravity and molecular forces into coloured groups of various shapes, and returning spontaneously when not returned forcibly into the parent film.

Production of Inductive Currents.—It has been discovered by Signor Blaserga, of Padua, that inductive currents are not produced instantaneously. Their development requires a definite period of time, which he has estimated at about $\frac{1}{200}$ of a second. He also states that when established an appreciable time is occupied in arriving at the maximum.

The Luminosity of Phosphorus.—Dr. Moffat read a paper before the British Association, and describes a number of experiments on the above.

From these experiments it was shown that phosphorus in a luminous state produced phosphorous and phosphoric acids, and ozone also; that it was non-luminous in a degree of temperature below 39° (F.), and that it was luminous above 45° (F.); but the temperature of luminosity and non-luminosity varied with the pressure of the atmosphere, and also with the direction of the wind. A series of experiments, extending over four years, had been made on the luminosity of phosphorus in connection with atmospheric conditions, and from the results it would appear that the equatorial or sea wind is that of phosphorescence and ozone, and that the polar or land wind is that of non-luminosity and no ozone. As the ocean is the reservoir of ozone, Dr. Moffat asks if it is not probable that its phosphorescence is the chief source of its development—a probability strengthened by the fact that the polar and land winds, in the shape of the NE. and SE. nodes, seem to modify its development as the land-current does.

Expansion of Limestone when burnt.—Herren Dorlhan and Saminn point out that two cylinders formed out of the same piece of limestone measured 27 millimetres in length and 17 millimetres in diameter. After being completely burned, their volume had increased nearly $\frac{1}{10}$,—viz., to 28 millimetres and 17.7 millimetres.

Measuring the Transparency of the Air.—M. de la Rive, of Geneva, lately sent a note to the French Academy, describing an apparatus for measuring the transparency of the air. According to M. de la Rive, the great transparency of the air before rain is due to the presence, in the air, of a quantity of invisible vapour, which renders transparent the numerous germs floating in the air, to whose presence light mists are attributed.—Vide *Comptes Rendus*, tom. lxiv., No. 23.

The Electro-deposition of Copper.—It very frequently occurs that the copper which is deposited by electric means is so brittle as to render it unfit for manufacturing purposes. A very simple and ingenious method of preventing this has been described by M. Bouillet, which we give our readers. M. Bouillet has found that a small quantity of gelatine dissolved in the water of the bath gives a copper of extensive malleability and nearly equal to rolled copper.

A Telegraphic Thermometer has been constructed by Professor Wheatstone, and was described at the British Association meeting. The details of its arrangement are too numerous for our columns, but the instrument is likely to be of immense value in meteorological inquiries. Professor Wheatstone gives the following account of its application to the purposes of meteorology:—In this class of instruments the indications are not spontaneously conveyed to the observer, but they must be asked for; and whenever this is done, the indications will be immediately transmitted to him, however frequently the question is put. The uses to which this telegraphic thermometer may be applied are, among others, the following:—The responder may be placed at the top of a high mountain and left there for any length of time, while its indications may be read at any station below. Thus, if there should be no insuperable difficulties in placing the wires, the indications of a thermometer placed at the summit of Mont Blanc may be read as often as required at Chamouni. A year's hourly observations under such circumstances would no doubt be of great value. If it be required to ascertain

during a long-continued period the temperature of the earth at different depths below its surface, several responders may be permanently buried at the required depths. It will not be requisite to have separate questioners for each, as the same may be applied successively to all the different wires. The responder, made perfectly watertight, in which there would be no difficulty, might be lowered to the bottom of the sea, and its indications read at any intervals during its descent. In the present mode of making marine thermometric observations, it is necessary that the thermometer should be raised whenever a fresh observation is required to be made.

ZOOLOGY AND COMPARATIVE ANATOMY.

Where to place Cryptoprocta ferox.—Since the singular carnivorous animal *Cryptoprocta ferox* was described by Bennet, there has been a difficulty as to referring the creature to its proper place in the order Carnivora. Bennet's specimens were all those of young animals, and the dentition being incomplete, of course they offered no reliable characters for the zoologist. The problem is now solved. MM. Milne-Edwards and Grandidier have laid before the French Academy a fine memoir on this species; in this they describe minutely the anatomical character of *Cryptoprocta*, which they place not in the family *Viverride*, but in that of the *Felide*. The *Cryptoprocta* is a plantigrade animal, and therefore it is determined to divide the *Felide*, like the *Carnivora*, into two groups, *Plantigrada* and *Digitigrada*, as is the case with the order. The *Cryptoprocta* will then be placed in the first division, being the only representative; while the other genera will come under the second section.—Vide *Comptes Rendus*, August 5.

The Muscular Systems of Birds and Mammals have been contrasted in a paper laid before the *Société Philomathique* by M. Alix. The author arrives at the not very novel conclusion, that the muscular system of birds presents elements absent from that of mammals, and that the muscular system of mammals presents elements absent from that of birds.—*L'Institut*, June 29.

Rearrangement of Asiatic Salamanders.—Mr. St. George Mivart professes to place one of the Asiatic salamanders, the *Plethodon persimilis* of Gray, in an entirely new genus, for which he proposes the name of *Pectoglossa*.

The Fore-limb of the Great Anteater has been submitted to a careful dissection by M. Pouchet, who enters into many important details. M. Pouchet states that in regard to the shoulder, wrist, and elbow-joints the *Myrmecophaga* presents many analogies with the Primates.—See the *Comptes Rendus*, July 1.

Mammalian Blood Disks.—We have received proofs from Professor Gulliver, F.R.S., of a paper on this subject, which will appear in the *Journal of Anatomy* for November. In this the author reiterates his belief that the classification of Vertebrates, founded on the character of the blood-corpuscles, still holds good. He divides Vertebrata into two groups:—(1) *Pyrenamata*, those whose blood-disks are nucleated; and (2) *Apyrenamata*, those whose corpuscles contain no nuclei. The former division includes the birds, reptiles, batrachians, and fish. The latter includes the mammalia only. Professor Gulliver concludes by stating that the corpuscles are as valuable indications

of specific characters in animals as are the raphides in plants, and he refers his readers to the article on the latter, which he wrote for the *Popular Science Review* some time ago.

Birds' Nests and Birds' Plumage.—One of the finest papers ever published on this most interesting point in Natural History, was that read by Mr. Wallace before the British Association at Dundee. It would be impossible to condense it into a paragraph, and we hope, therefore, that the author will print it in full in some of the periodicals. It described the peculiarities of plumage which protect birds when sitting on their eggs, and was another convincing argument in favour of Mr. Darwin's hypothesis.

New Fishes.—At a meeting of the Vienna Imperial Academy of Science, Herr Steindacher recorded the discovery of several new species of fishes, which he ranges under the genera of *Glyptosternon*, *Caranx*, *Batrachus*, *Arius*, *Balistes*, *Heros*, and *Ctenolabrus*.

The Ray Society's future Publications.—The books issued by the Ray Society are always so well selected, and so admirably executed, that naturalists are glad to know what a treat they have to anticipate. We therefore give the names of the works in preparation for future years, which are as follow :—Professor Allman on the "British Corynidæ." The volume of plates to the edition of the works of the late Robert Brown, edited by J. J. Bennett, Esq., F.R.S. Rev. O. P. Cambridge, a supplementary volume on "British Spiders." Messrs. Douglas and Scott on the "British Hemiptera Homoptera." Dr. Gærtner on "Hybridism in Plants" (*Bastarderzeugung*), translated from the German by W. Carruthers, Esq., F.L.S. Mr. Hancock on the "British Tunicata." Sir John Lubbock on the "British Thysanura." Dr. McIntosh on the "British Annelids." Dr. Masters on "Vegetable Teratology." Mr. St. George Mivart, "Monograph of the Tailed Amphibia." Mr. Andrew Murray on the "Coniferæ." "A Synopsis of the Fauna and Flora of Palestine," by the Rev. H. B. Tristram, F.L.S. Professor Westwood on the "Mantidæ," with illustrations by Mr. E. A. Smith. The Council have also under consideration a proposition for an important and expensive botanical work, with reference to which the only difficulty is the financial element.

The Boring of Annelids.—Mr. E. Ray Lankester read a paper before the British Association on the mode by which annelids make borings in rocks. The conclusion at which he arrived, which seems supported by probability, is that worms like the *Echinus lividus* make their borings by means of carbonic acid. Worms bore only rocks composed of carbonate of lime, which, though insoluble in water, are readily dissolved by solution of carbonic acid. Mr. Lankester thought the subject of the boring of worms quite uninvestigated, and instanced two genera which perforate rocks extensively.

The Anatomy of the Pilot Whale formed the subject of a paper read by Professor Turner. The anatomy of the stomach and of the great arteries was described by the author. Professor Turner compared the stomach of the pilot whale with that of the porpoise, and stated that the former contained a greater number of compartments than the latter.

Dodo-like Birds of the Mascarene Islands.—The Committee appointed in 1865 to investigate this group, has produced little result beyond the col-

lection of a number of bones from Rodriguez. Professor Newton made some general remarks upon the specimens collected, and he especially dwelt on an unexpected confirmation of the testimony of Leguat, by the discovery of an extraordinary bony knob near the extremity of the wing. Leguat, whose account of the "Solitaire's" habits was the only one we possessed, mentioned a curious "ball," as big as a "musket bullet," which the male birds possessed under their wing feathers. Now, the existence of this ball was proved by the bony knob exhibited, and thus the veracity of old Leguat—who was a Huguenot refugee—on this point, as on so many others, was confirmed. In conclusion, Professor Newton called attention to the fact that at present we only knew of the didine bird of the island of Reunion, *that it was white*. In the course of last year, Mr. Tegetmeier had shown him an old watercolour painting of a white dodo, and this, he was inclined to believe, might represent this lost species, of which he trusted the French naturalists in that island would succeed in obtaining actual relics.

The Shetland Dredging Committee.—Mr. J. Gwyn Jeffreys read the preliminary report of the Committee for the present year. From this it seems that the further investigation is carried on in the Shetland seas, the more deeply interesting does the study of the fauna of that portion of the country become. Dredging in the depths of those northern seas, in which there is, almost invariably, a heavy sea—at one time sweeping across the Atlantic, at another rolling away from Greenland, at another (as was the case for many weeks together during the present summer) running for Spitzbergen and the ice-floes of the Arctic Ocean, accompanied by a keen cutting north-east wind—is not altogether pleasant work for the naturalist. Yet, trying and difficult though the dredging be, there is none to be compared with it in the British Islands, and every fresh summer the Dredging Committee have spent in investigating the marine fauna of Shetland, they have returned home only the more convinced of the greatness of the field of research which remains to be explored. Every square mile of the sea seems to have treasures to give up unknown before, and the extent of the riches which lie there—one, two, three, four hundred fathoms deep—will perhaps never be known in our day. The extreme interest which attaches to the Shetland sea is the circumstance that it is the trysting-place of the northern and southern faunas. The wave influence of the Gulf Stream, infringing on the western coast, coaxes on many a species of sunnier climes to extend its migration northwards; while the cold winds and waves which issue from the Pole, and come drifting round the West Cape, account for the many Arctic forms which, stunted in size and numerically scarce, are yet able, in the equable temperature of the abyss of the Shetland waters, to hold out against those southern influences so detrimental to their constitutions.

Development of the Eye in Fishes.—Herr Schenk lately sent in a paper to the Imperial Academy of Vienna, in which he described the development of the eye of the trout. He stated that the lens is developed from the external germinal lamella, and that the retina is produced from the thick inner wall of the ocular vesicle, the thin inner wall contributing to the formation of the pigment layer of the choroid.

Embryology of Pelobates fuscus.—The development of *P. fuscus*, a tailless amphibian, has been watched by M. Van Bambeke. Some of the author's

conclusions have a special embryological interest. He has found that (as pointed out by Quatrefages in other animals) the disappearance of the germinal vesicle takes place independently of fecundation. The other points are as follows:—1. The ovarian ovum has no vitelline membrane; 2. The embryos adhere to one another on leaving the egg; and 3. The ovum presents a *germinal fossa* which is not an aperture, but which the author compares to the *micropyle*.—Vide *L'Institut*, August 28.

How to detect the Silkworm Malady.—M. Pasteur's method, which consisted in selecting a number of worms, pounding them in a mortar, and then submitting the mass to the microscope, was neither simple nor economical. The method which M. Balbiani suggested recently seems a better one. When in the chrysalis state, a very small portion of the projecting process which represent the future wing is snipped off with a pair of scissors, and is placed under the microscope; if now the larva be diseased, the peculiar pebrine corpuscles can be distinctly seen. The advantage of M. Balbiani's method is that it does not involve the death or injury of the silkworm.

Reproduction of Limbs in the Axolotl.—The axolotls (specimens of which may now be seen at the Zoological Gardens in Regent's Park) have lately formed the subject of experiments by M. Dumeril. M. Dumeril found that in these animals, as in the newt, there is no regeneration of amputated limbs unless the basilar segment (scapular or ilium) is left untouched by the knife. M. Vulpian's recent observations, recorded to the *Société Philomathique*, also prove the fact of regeneration. M. Vulpian finds that when a number of axolotls are together, it not unfrequently happens that, from bites and other injuries, portions of the young limbs are destroyed. The consequence of this is not simply the reproduction of the part destroyed, but the formation of even a greater number of parts than were normally present before the injury. This, he says, is the reason why we so often find specimens of axolotls whose fore-limbs have five or six digits, instead of four, and whose hind ones have as many as six or seven extremities, instead of five.

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